

MOSS FLORA

OF

NORTH AMERICA

North of Mexico

BY

A. J. GROUT, PH.D.

FELLOW AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE; MEMBER
BOTANICAL SOCIETY OF AMERICA; FOUNDER AND ASSOCIATE EDITOR OF
THE BRYOLOGIST; MEMBER ALL YEAR STAFF, BIOLOGICAL
LABORATORY, COLD SPRING HARBOR, L. I., N. Y.

ALOINA

By MRS. ETHELDA J. CRAIG

TORTULA

By WILLIAM CAMPBELL STEERE, PH.D.
University of Michigan

POTTIA AND PTERYGONEURUM

By W. T. WAREHAM
Ohio State University



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POTTIEAE.

Leaves mostly broad as compared to their length, ovate, lingulate, or spatulate; *costa with a single dorsal stereid band*, often excurrent into a hair point; basal cells usually rectangular, elongated, hyaline or translucent; upper cells smaller, rounded-quadrate to hexagonal; seta terminal, mostly elongated with capsule long-exserted.

In *Trichostomopsis* and *Husnotiella* the leaves are narrower and oblong to lanceolate but there is only a dorsal stereid band.

In *Acaulon* and *Phascum* the capsules are cleistocarpous and in most cases immersed.

KEY.

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|--|---|
| 1. Costa with ventral assimilation organs, filaments, sacs, or lamellae..... | 2. |
| Costa without such ventral organs..... | 4. |
| 2. Costa with lamellae..... | 4. <i>Pterigoneurum</i> . |
| Costa with filaments..... | 3. |
| 3. Stem without central strand; leaves with incurved margins rarely hair-pointed
(except <i>A. rigida</i> var. <i>pilifera</i>)..... | 5. <i>Aloina</i> . |
| Stem with central strand, leaves hair-pointed; with margins plane or revolute. | 6. <i>Crossidium</i> . |
| 4. Plants very small; capsules cleistocarpous, mostly immersed..... | 5. |
| Plants larger; capsules with well developed operculum and long-exserted (except
<i>Pottia</i> species)..... | 6. |
| 5. Capsules subglobose, not apiculate; leaves mostly smooth..... | 1. <i>Acaulon</i> . |
| Capsules subglobose to ovoid, mostly apiculate; leaves papillose or smooth... | 2. <i>Phascum</i> . |
| 6. Leaves not papillose but strongly mamilllose both sides..... | 12. <i>Bryobrittonia</i> . |
| Leaves papillose to smooth or nearly so..... | 7. |
| 7. Leaves bistratose above and on the margins..... | 9. <i>Trichostomopsis</i> . |
| Leaves not bistratose except sometimes on narrow margins..... | 8. |
| 8. Leaves plainly bordered by cells elongated, or of a different color, shape or
structure..... | 13. |
| Leaves not so bordered..... | 9. |
| 9. Peristome lacking or of merely a low inconspicuous membrane..... | 10. |
| Peristome well developed..... | 11. |
| 10. Costa thickened or spurred above; peristome of a narrow membrane..... | 7. <i>Husnotiella</i> . |
| Costa not thickened or spurred above; peristome lacking..... | 3. <i>Pottia</i> . |
| 11. Peristome teeth from a narrow basal membrane, usually short and untwisted,
never twisted more than 1 turn..... | 12. |
| Peristome teeth from a wide basal membrane, usually twisted more than one
turn..... | 10. <i>Tortula</i> . |
| 12. Peristome teeth short and undivided but often irregular or perforate..... | 3. <i>Pottia</i> . |
| Peristome teeth (with few exceptions) divided nearly to the base into two
(rarely 3) slender filiform prongs, sometimes slightly twisted..... | 8. <i>Desmatodon</i> . |
| 13. Leaves bordered below by a narrow band of elongate cells in 2-3 layers..... | 14. |
| Leaves bordered above by cells of different color or structure..... | 15. |
| 14. Peristome absent..... | <i>Pottia Randii</i> . |
| Peristome present..... | <i>Desmatodon cernuus</i> and <i>D. Laureri</i> . |
| 15. Peristome lacking..... | 11. <i>Merceya</i> . |
| Peristome well developed..... | 11. |

1. ACAULON C. Muell. Bot. Zeit. 5: 99. 1847.

Sphaerangium Schimp. Syn. 12. 1860.

Plants minute, bulbiform, gregarious; stem very short, without central strand, simple, from a persistent protonema; upper leaves larger, concave, convolute, often with spreading tips, upper margin plane and entire or revolute and sinuate-denticulate; costa excurrent into a short point, without guide cells; upper leaf cells short-rhombic, smooth or nearly so (except in *Schimperianum*), larger and looser below, the lowest thin-walled and rectangular. Dioicous; seta very short; capsule subglobose, almost or quite without apiculus, cleistocarpous, immersed; calyptra minute, irregularly torn at base. Type species, *A. muticum*?

KEY.

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| 1. Leaves papillose both sides, ecostate below. | 4. <i>Schimperianum</i> . |
| Leaves smooth or lightly papillose at back only, costate to the base. | 2. |
| 2. Plants subglobose, more or less three-cornered; seta longer than the vaginule; spores mostly under 30 μ , finely and sharply papillose. | 3. <i>triquetrum</i> . |
| Plants ovoid-bulbose; seta shorter; spores over 30 μ , smooth or finely granulated | 3. |
| 3. Basal leaf cells up to 100 μ long; spores finely granulated, 30-40 μ in diameter. | 1. <i>rubrum</i> . |
| Basal leaf cells up to 90 μ ; spores 40-50 μ , smooth. | 2. <i>rufescens</i> |

1. ACAULON RUBRUM (Röhl.) n. comb.

Phascum rubrum Röhl. Ann. Wett. Ges. 1: 187. 1809.*Phascum bulbosum* Voit. Musc. Herb. 8. 1812.*Acaulon muticum* (Schreb.) C. Müll. Bot. Zeit. 5: 99. 1847.*Sphaerangium muticum* Schimp. Syn. (Ed. 1) 13. 1860.

Plants gregarious, minute, when mature and fruiting reaching 2 mm. high including the leaves, oblong-ovoid in outline and slightly cuspidate by the tips of the entirely smooth leaves, the lower minute, the upper and perichaetial much larger, very concave, cymbiform, convolute, not keeled, enclosing the capsule, *revolute near the apex only*, irregularly sinuose-dentate near the broadly acute to blunt apex; costa distinct, percurrent, usually excurrent into a short mucro in the uppermost leaves; lower leaf cells hyaline, rectangular, up to 20 x 150 μ , longer and narrower towards the margin; upper median smaller rhomboid-hexagonal, 2-3 : 1. Seta straight, much shorter than the capsule, which is immersed, spherical or with a minute apiculus, about 0.5 mm. in diameter; calyptra minute; spores 30-40 μ , finely granulated, mature in winter to early spring. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. *pl.* 4; Limpr. Laubm. 1: 179. *f.* 65; Dixon, Handb. Brit. Mosses (Ed. 3) *pl.* 22C; *Pl.* 92.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 32, (Ed. 1) 25, at least in part; Aust. Musc. Appal. 51?

On bare soil, Illinois, Maryland (*J. D. Smith*), California (*Bolander*). Bolander's plants are very immature with smooth spores. Spore characters are very important in this genus, but it is evident that only mature spores are characteristic. This species is very rare in N. America.

2. ACAULON RUFESCENS Jaeg. Musci Cleist. 19. 1869.

Sphaerangium rufescens Jaeg. Adumb. 1: 183. 1871-1872; Lesq. & James, Man. 40. 1884.

Described as intermediate between *A. rubrum* and *A. triquetrum*, but nearer the former. Plants subglobose, not three cornered; leaf margins sharply reflexed above and rather coarsely dentate in most plants; costa sometimes excurrent, more frequently percurrent or ending slightly below the apex; basal leaf cells usually shorter, 60 rarely 90 μ long; spores 40-50 μ , smooth. Type locality, eastern U. S.

ILLUSTRATIONS:—Roth, Aussereu. Laubm. 1: *pl.* 20, *f.* 8; *Pl.* 91 & 92.EXSICCATI:—Aust. Musc. Appal. 52 (as *Sphaerangium muticum*); Grout, Musci Perf. 258. In Austin's 52 the spores are immature but smooth and mostly less than 40 μ in diameter.

Widespread east of the Rocky Mountains; Arizona (*Bartram*). It is probable that all our eastern plants referred to *rubrum* or *triquetrum* belong here.

A. rufescens should be regarded as a geographical subspecies of the European *rubrum*.

3. ACAULON TRIQUETRUM (Spruce) C. Muell. Bot. Zeit. 5: 100. 1847.

Phascum triquetrum Spruce, Jour. Bot. 1845: 189. 1845.

Sphaerangium triquetrum Schimp. Syn. (Ed. 1) 14. 1860.

Plants bulbiform, subglobose, about 1 mm. high, distinctly triquetrous; lower leaves minute; the inner and perichaetial broadly ovate, carinate, deeply concave, with the upper margins more or less reflexed, less denticulate than in the two preceding; costa also more strongly excurrent into a more or less recurved apiculus; basal leaf cells up to 60 μ long by 20 μ wide, 2-4 : 1, rectangular for the most part; the upper rhomboidal to hexagonal, often as broad as long, all narrower toward the margin; seta curved, nearly as long as the capsule; spores mostly under 30 μ , rough with minute sharp spines, mature in early spring. Type locality European, near Strassburg.

ILLUSTRATIONS:—Bry. Eur. pl. 4; M. H. M. f. 67; Dixon, Handb. Brit. Mosses (Ed. 3) pl. 22D.

EXSICCATI:—Drumm. Musc. Am. 8, as *A. muticum*; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 25.

On clayey or sandy unoccupied soil; western Canada to New England, south to S. Carolina. Rare or overlooked. The triquetrous form is often obliterated in the dry plants. The smaller, finely and sharply roughened spores seem the easiest distinguishing character in fully matured plants.

4. ACAULON SCHIMPERIANUM Sull. Mosses U. S. 15. 1856; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 26.

Plants minute, bulbiform, including the leaves 1-1.5 mm. high, copiously radiculose at base; lower leaves minute, the upper and perichaetial larger, 1-1.5 mm. long including the excurrent costa, broadly ovate, strongly concave and convolute, recurved at the apex, coarsely and irregularly toothed above with the teeth often double pointed, strongly papillose on both sides except near the base; the excurrent costa usually not extending below the middle, but in some plants (Holz. Musc. Acro. Bor. Am. 601) very strong and extending nearly to the base in some of the upper leaves; leaf cells thin-walled, the upper 25-30 μ wide, 1.7-3 : 1, the lower more elongated and rectangular. Male plants smaller, mixed with the female, bearing 3-4 leaves, 2-3 antheridia and no paraphyses; seta short, about $\frac{1}{2}$ the diameter of the capsule, curved; capsule globose, apiculus scarcely perceptible; calyptra minute; spores very finely papillose, appearing nearly smooth, 30 μ or more in diameter, mature in winter. Type locality, San Marcos, Texas (Wright).

ILLUSTRATIONS:—Sull. Icones Musc. pl. 9; Pl. 92.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 26 (the type collection), (Ed. 2) 33; Holz. l. c. 601; Bartram, Mosses S. Arizona 115.

Although Holzinger's 601 from Arizona (Bartram) has the upper leaves with a much stronger costa than is found in the type, it is evidently the same species.

2. PHASCUM [L.] Hedw. Sp. Musc. 19. 1801.

Plants small, gregarious; stems 1-2 mm. high, without central strand, simple or divided; leaves ovate to broadly lanceolate, mostly entire with revolute margins; costa strongly excurrent, in cross section showing guide cells and a single dorsal stereid band; upper leaf cells quadrate to hexagonal, warty papillose on both sides (except *P. hyalinotrichum*), basal leaf cells larger, hyaline and more generally rectangular, less strongly papillose. Autoicous or synoicous; seta very short, sometimes curved; capsule usually immersed, sometimes slightly emergent, subglobose to ovoid, *apiculate*, operculum not differentiated; calyptra cucullate, rarely mitrate.

The original *Phascum* of Linnaeus and later as modified by Hedwig was so composite and ill defined that it is difficult to say what species should be assigned to it, or what its type species is according to any strict rules of nomenclature. *Pleuridium subulatum* is the first species mentioned in Hedw. Sp. Muscorum. *P. curvicolium* is the first species he mentions there that is now included in the genus. *P. cuspidatum* is the best known and most widely distributed species and should probably be considered the type.

The specimen of *P. subexsertum* described by Hooker in Drummond's Musc. Am. no. 9. 1828, can not be found. The plant described by Schwaegrichen, Suppl. 4: pl. 302b. 1842 is *P. bryoides* Dicks (now transferred to *Pottia*) according to Cardot, Bull. L'Herb. Boiss. 7: 363. 1899.

The American plant referred to *P. carnicolum* Web. & Mohr, in the Lesq. & James Manual p. 42 is not that species but an *Aschisma*, *A. kansanum* Andrews, Torreyia 15: 63. 1915. (See p. 151 of this volume.)

Hall's specimens of *Pottia subsessilis* from the Field Museum of Natural History show no plants of *Phascum Floerkeanum* Web. & Mohr and none can be found at Harvard, the U. S. National Museum or the

New York Botanical Garden. It is probably safe to say that the species has not yet been found in North America.

Bush says (Bryol. 19: 73) of the plants referred to this species by Cardot, Coll. Demetrio, "seems to me to be only another collection of *Phascum cuspidatum americanum*."

KEY.

Leaf cells strongly papillose.....	1. <i>cuspidatum</i> .
Leaf cells smooth.....	2. <i>hyalinotrichum</i> .

1. PHASCUM CUSPIDATUM [Schreb.] Hedw. Sp. Musc. 22. 1801.

Phascum acaulon L. Sp. Pl. 1570. 1753.

Phascum polycarpum Bry. Eur. fasc. 1. pl. 6. 1937 (the first printing).

Plants densely tufted, 1–2 mm. high, occasionally more, often branched; upper leaves largest, ovate to oblong-lanceolate, acuminate, carinate, entire, with margins more or less revolute in the middle, somewhat twisted when dry, up to 2 mm. or more long; costa smooth, excurrent; leaf cells rectangular and hyaline below, less papillose, above hexagonal, rhomboidal to shortly rectangular, 15–30 μ in greatest dimension, finely papillose at back. Capsules about 1 mm. long on short straight or curved setae of varying length, sometimes 2–3 together, ovoid-globose, immersed or slightly emergent, obtusely apiculate, cleistocarpous; calyptra cucullate, not reaching the capsule middle; spores 24–35 μ , mature in spring; antheridia clustered in the axils of the upper leaves. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. pl. 5; Dixon, Handb. Brit. Mosses (Ed. 3) pl. 22E; Limpr. Laubm. 1: figs. 68–70; M. H. M. f. 68.

EXSICCATI:—Drumm. Musc. Am. 5. This and specimens collected by Prof. F. L. Pickett near Pullman, Washington seem to match the European plants very closely. The other American plants studied seem to belong to

1a. Var. AMERICANUM Ren. & Card. Bot. Gaz. 30: 12. 1900.

Var. *piliferum* of American authors.

Costa long excurrent, often decolored at apex, nearest to var. *piliferum* (Schreb.) Hook. but leaves shorter, 2 mm. or less; seta shorter, erect. The leaves of American plants are usually much broader than figured in the Bry. Eur. and the awn in some cases is nearly the length of the leaf blades; leaves more strongly papillose especially along the margins. Pl. 91C.

On the same page Cardot & Thériot state that *Microbryum Floerkeanum* var. *Henrici* Ren. & Card. (Bot. Gaz. 14: 91. 1899) is only a stunted form of this variety.

EXSICCATI:—Drumm. Musc. Am. 6, as var. *elatum*; Grout, Musci Perf. 299; R. & C. Musc. Am. Sept. 267.

On soil of banks and old fields; rare or at least infrequently collected; widely distributed in southern Canada and in the U. S.; south to Virginia, Oklahoma and Arizona.

The length of the excurrent costa and the width of the leaves is extremely variable and the var. *piliferum* seems of little consequence. Var. *americanum* seems a pretty well marked geographical variant.

The spores also vary a great deal in size and roughness.

The lower leaves and leaves of immature plants strongly resemble those of *P. Floerkeanum* but can be distinguished by the larger leaf cells.

Cheney has collected along the banks of the upper Mississippi "a small brown form" which seems to be much like that mentioned by Dixon, l. c. page 177 as "usually growing on clay." Drummond's no. 6 seems to be the same thing.

2. PHASCUM HYALINOTRICHUM Card. & Thér. Bot. Gaz. 37: 363. pl. 16. 1904.

Plants very small, solitary or gregarious, pale green; leaves imbricate, the lower short, the upper larger reaching 2 mm. with awn, median and upper ovate, 0.8–1 mm. long by 0.6 mm. broad, concave, acuminate, entire or subentire; margins plane or slightly reflexed below; costa narrow, 24 μ wide in the middle of the leaf, attenuate below, excurrent into a piliferous point $\frac{1}{2}$ – $\frac{1}{3}$ the length of the leaf, flexuous and hyaline; areolation lax, *entirely smooth*, slightly chlorophyllous, hyaline above; median leaf cells irregular, quadrate, shortly rectangular or subhexagonal, 18–30 x 12–18 μ , thick-walled, the lower larger and thinner-walled, the upper longer and incrassate. Capsule on a very short (0.2 mm.) geniculate seta; capsule immersed,

globose apiculate, 0.7 mm. in diameter; calyptra cucullate, covering the upper $\frac{1}{2}$ of the capsule; mature spores unknown. Type locality, Soldier's Home, Los Angeles Co., California (Dr. Hasse, 1902, in Herb. C. F. Baker). *Pl.* 92.

"A quite peculiar species, very distinct by its habit, which recalls that of an *Acaulon*, its puliform excurrent nerve and its loose smooth areolation, a little chlorophyllose below and hyaline above." Type duplicate seen.

3. POTTIA [Ehrhart] Fűrnröhr in Flora 12²: 10. 1829.

By R. T. Wareham*

Anacalypta Röhl. Moosg. 109. 1800.

Mildeella Limpr. Laubm. 1: 191. 1890.

Stegonia Vent. Rev. Bryol. 10: 96. 1883.

Plants small to medium sized, caespitose to sod-forming, usually growing on soil but occasionally on earth-covered rocks; stems simple or branched, with a central strand (except *P. Randii*, *P. texana*, *P. bryoides* and *P. Fosbergii*), bearing rhizoids only at the base; leaves tufted, erect, spreading, or closely imbricated (resulting in a bulbiform plant), broadly ovate to lanceolate or lingulate to spatulate, usually papillose in upper and smooth in lower half, concave, often keeled; margins entire to toothed, plane to recurved, sometimes slightly incurved in *P. nevadensis*; cells in upper half quadrate to hexagonal, thin- to thick-walled, occasionally slightly collenchymatous; below elongated, thin-walled and hyaline; costa subpercurrent to long excurrent, usually quite strong, biconvex, frequently papillose on both sides, in cross section with dorsal stereid band only; perichaetial leaves usually scarcely different from the others. Paroicous, synoicous or polyoicous; antheridia and archegonia borne naked or with thread-like to almost clavate paraphyses; seta with a central strand, elongated, straight to flexuose, usually twisted when dry; capsule long-exserted in all our species (except some forms of *P. bryoides*), yellowish to reddish-brown, obovate to ovate to long-cylindric, with a rounded base to distinctly short-necked, symmetric to somewhat arcuate, narrow- to wide-mouthed when deoperculate, bearing phaneropore stomata on the rounded base or on the neck; annulus sometimes not differentiated, when present persistent to detachable (persistent when present in all our species); calyptra cucullate, smooth to very scabrous; spores papillose to tuberculate, 8-50 μ in diameter (18-50 μ in our species). Type species *P. truncata*.

Brotherus in Engler & Prantl, Pflanzenfam. 10: 289. 1924 classified 51 species of the genus into four sub-genera. These, along with *Stegonia* Vent., are here treated as sections of the genus *Pottia*.

I. *Schizophascum*. Capsule always exserted, short-necked, beaked, bursting at maturity.

2 Australian species. *P. Fosbergii* probably belongs here.

II. *Pottiella*. Seta as long or a little longer than the capsule. Capsule without neck, with operculum small, short-pointed to obliquely beaked, persistent.

2 species. Neither one known in North America.

III. *Mildeella*. Seta shorter or longer than the perichaetial leaves, erect. Capsule short-necked, with persistent, oblique, cone-shaped operculum and peristome consisting of 16, two-layered, thread-like, papillose, yellow teeth.

1 species. *P. bryoides*.

IV. *Eupottia*. Capsule always exserted, operculum deciduous, leaves erect to spreading.

49 species. *P. Randii*, *lanceolata*, *truncata*, *nevadensis*, *Heimii*, *Starkeana*, *texana*, and *arizonica* occur in North America.

V. *Stegonia*. Leaves closely imbricated and very concave resulting in a bulbiform plant, weakly chlorophyllose, smooth.

2 species. *P. Mouretii* from Morocco and *P. latifolia*.

The following species of *Pottia* recorded from North America, north of Mexico are excluded from the list: *P. intermedia* (Turn.) Fűrnr. (See p. 201), *P. litoralis* Mitt. (See p. 201), *P. mutica* Vent. (See p. 202), *P. Davalii* (Sm.) comb. nov. = *P. minutula* (Schleich.) Bryol. Eur. = *P. rufescens* (Schultz) Warnst. (See p. 201), (*P. Wilsoni* (Hook.) Bry. Eur. (See p. 203).

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KEY TO SPECIES.

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|---|--------------------------------|
| 1. Leaves smooth to very sparsely papillose in upper half | 2. |
| Leaves densely papillose in upper half | 8. |
| 2. Plants bulbiform; capsule peristomate | 3. |
| Plants not bulbiform, leaves erect or spreading; capsules gymnostomous or peristomate | 4. |
| 3. Leaves blunt to short apiculate | 11. <i>latifolia</i> . |
| Leaves long-awned by the excurrent costa | 11a. var. <i>pilifera</i> . |
| 4. Capsules arcuate; leaf margins 2-3 cells thick below the middle | 7. <i>Randii</i> . |
| Capsules symmetric; leaf margins not thickened | 5. |
| 5. Leaves entire to serrulate by projecting transverse walls near apex, margins plane to recurved at the middle | 6. |
| Leaves (some on every plant) coarsely toothed near apex | 7. |
| 6. Peristome present; leaf margins mostly recurved | 8. <i>lanceolata</i> . |
| Peristome lacking; leaf margins mostly plane | 3. <i>truncata</i> . |
| 7. Costa excurrent into a smooth awn in most leaves | 9. <i>nevadensis</i> . |
| Costa subpercurrent to forming a strong, short mucro | 10. <i>Heimii</i> . |
| 8. Capsules cleistocarpous | 9. |
| Lid separating from the urn when mature | 10. |
| 9. Lid distinguished from urn by a band of quadrate cells; peristomate | 2. <i>bryoides</i> . |
| Lid not distinguished by a band of quadrate cells; peristome lacking | 1. <i>Fosbergii</i> . |
| 10. Leaves usually bordered by 2-6 rows of less papillose, yellowish cells; margins plane, usually coarsely toothed above; lid systylous | 11. |
| Leaves not bordered; margins recurved; lid not systylous | 12. |
| 11. Leaves acute to acuminate, usually coarsely toothed above | 10. <i>Heimii</i> . |
| Leaves obtuse, usually entire to serrulate | 10a. var. <i>obtusifolia</i> . |
| 12. Leaves serrulate by projecting transverse walls; calyptra smooth; seta twisted to right below and to left above | 8. <i>lanceolata</i> . |
| Leaves entire except for papillae; calyptra papillose; seta twisted to right or left | 13. |
| 13. Spores regularly tuberculate, not papillose; seta ordinarily 2-3 mm. long | 5. <i>Starkeana</i> . |
| Spores irregularly tuberculate or non-tuberculate, mostly papillose | 14. |
| 14. Spores densely and coarsely papillose, brown, almost opaque; capsule gymnostomous; upper leaf cells mostly 12-15 μ wide, quadrate | 4. <i>texana</i> . |
| Spores irregularly tuberculate to non-tuberculate, mostly minutely papillose and yellow-transparent, upper leaf cells mostly 9-12 μ wide, hexagonal | 15. |
| 15. Costa short-excurrent to forming an awn up to 0.26 mm. long; peristome well-developed | 6. <i>arizonica</i> . |
| Costa subpercurrent to short-excurrent; peristome lacking or consisting of a basal membrane only | 6a. var. <i>mucronulata</i> . |

1. POTTIA FOSBERGII Bartram, Bryol. 33: 18. pl. 2. 1930.

Plants small, gregarious; stems without central strand, up to 1 mm. long, often branched at base; leaves erect to somewhat spreading, broadly ovate to oblong, *acute to short-acuminate to minutely apiculate, concave*; the upper ones 0.8-1.3 mm. long, much shorter below; leaf cells in upper part 13-17 μ wide, quadrate to hexagonal, chlorophyllose, densely papillose, with medium thick walls, not collenchymatous; progressively longer and wider and less papillose toward the base; basal cells hyaline, thin-walled, 18-30 μ wide, mostly rectangular, up to 3-1; margins recurved from the base to or near the apex, entire below, usually slightly serrulate above; *costa yellowish*, percurrent or subpercurrent, area of thick-walled cells in cross section up to 35 μ wide. Paroicous; antheridia about 0.16 mm. long, with thread-like paraphyses, in the axils of the upper leaves; archegonia terminal with a few paraphyses; sporophyte single; seta with small central strand, flexuose or slightly curved, 2-3 mm. long, yellow; capsule brown, *cleistocarpous*, 0.9-1.5 mm. long, 0.35-0.44 mm. wide, oval-elliptic, often slightly unsymmetric, with a *short, conic, somewhat oblique, persistent beak, not distinguished from the urn by quadrate cells*; neck scarcely distinct; stomata on the capsule

base; exothecial cells thin-walled, 15–20 μ wide, quadrate to short-rectangular in small forms, typically quite regularly 4–1, square or pointed at the ends, shorter toward the base and apex; *peristome lacking*; calyptra cucullate, *smooth*; spores light brown, finely papillose, 23–30 μ in diameter; mature in spring. Type locality East side Indian Hill, Claremont, Los Angeles Co., California.—F. R. Fosberg. •

ILLUSTRATIONS:—Bryol. 33: 19, pl. 2. 1930; Pl. 95 and 103.

EXSICCATI:—Pomona Col. Herb., Mosses of So. Calif. D24a, in Herb. of E. B. Bartram, Bushkill, Penn. (The TYPE); Templeton Crocker Exped. Calif. Acad. Sci., Flora of Lower Calif.; New York Bot. Gard., Herb. Marshall A. Howe, Feb. 1895, as *P. Starkeana*, in part; Farlow Crypt. Herb., Herb. Clara E. Cummings, Coll. O. D. Allen, Feb. 20, 1885, as *P. Starkeana*, in part; U. S. Nat. Herb., Crypt. Coll. John Leiberg, as *P. Starkeana*, in part.

On soil. Four collections from Southern California and one from Lower California. Three of these collections were labeled and contained some *P. Starkeana*. Smaller than *P. bryoides* with a relatively longer seta; further distinguished from it by the absence of quadrate cells between the lid and the urn and absence of a peristome. Distinguished from *P. recta* by the longer seta and capsule, the percurrent costa, smooth calyptra and minutely papillose spores. The lack of differentiation between lid and urn and the absence of a central strand are characteristic of the genus *Phascum*, however the long-exserted, long-elliptical capsule, and the percurrent costa are characteristic of some *Pottias*. It is possible that it should be treated in *Phascum*. Certainly it belongs somewhere between typical *Phascum* and typical *Pottia*.

2. POTTIA BRYOIDES (Dicks.) Mitt. Ann. and Mag. Nat. Hist. (Ser. 2) 8: 311. 1851.

Phascum bryoides Dicks. Plant. Crypt. Brit. fasc. 4: 3, pl. 10, fig. 3. 1801.

P. gymnostomoides Brid. Spec. Musc. 1: 7. 1806; and Bryol. Univ. 1: 48. 1826.

P. elongatum Schultz, Fl. Starg. 273. 1806.

P. graniferum Wahl. Vet. Acad. Nya Handl. 27: 131, pl. 4, fig. 3. 1806.

P. pusillum Schleich. Cat. 1815.

P. subexsertum Schwägr. Suppl. 4: pl. 302b. 1842.

Tortula bryoides Lindb. Musc. Scand. 21. 1879.

Mildeella bryoides (Dicks.) Limpr. Laubm. 1: 192. 1890.

Plants including sporophytes from 2–10 mm. high, usually about 5–7 mm., sod-forming; stems simple or occasionally branched, without central strand; leaves imbricated, erect, concave, keeled, ovate to broadly lanceolate to lanceolate, acuminate, narrowed to the insertion, twisted when dry; costa yellowish, strong, excurrent, forming a *smooth, yellowish-brown* awn; upper leaves up to 3.2 mm. long by about 1 mm. wide, progressively smaller toward the base of stem; perichaetial leaves not differentiated; margins narrowly recurved from the base to very near the apex in most leaves, entire below, faintly serrulate near apex in most specimens; some specimens papillose along the upper part or the whole margin; median cells irregularly oblong to quadrate, 15–21 μ wide, usually a little longer than wide, papillose on both sides, sometimes almost smooth, fairly thick-walled, sometimes almost collenchymatous; basal cells about twice as large, oblong, smooth, thin-walled, hyaline, the lower two or three rows smaller, usually brown. Autoicous; antheridia usually naked, at the ends of short basal branches bearing several minute, costate leaves; capsules emergent to long exserted; seta with central strand, light brown to reddish, straight to slightly curved, usually twisted to the left when dry, 1.0–4.5 mm. long, usually 2–3 mm.; urn 0.5–0.8 mm. x 0.7–1.7 mm., erect to slightly inclined, *usually slightly unsymmetrical, short necked*, with stomata on the neck; exothecial cells thin-walled, irregularly oblong, about 20 μ wide at middle of urn; lid *persistent, differentiated* by 2–4 rows of smaller, rounded cells, long-conic to short-rostrate, oblique; cells of the lid elongated, *usually steeply spiraled to the left*; peristome more or less *rudimentary to quite well-developed*, when complete consisting of 16 narrow, pale, papillose teeth on a short basal membrane, the whole structure more or less fused with the inner layers of the lid, difficult to find except in mature specimens and then usually only by splitting the lid; calyptra cucullate, smooth to slightly papillose, covering about one-half the urn; spores papillose, 22–38 μ in diameter; mature in spring. Type locality, Europe.

ILLUSTRATIONS:—Limpr. Laubm. l. c. 191 and 193, figs. 72–75; Schwägr. Suppl. 1: pl. 1 and 4: pl. 302b, top; Braith. Brit. Moss Flora 1: pl. 28C; Bryol. Eur. pl. 6 (drawings very inaccurate); Dixon Handb. Brit. Mosses (Ed. 3), pl. 22 I. 1924; Pl. 94.

EXSICCATI:—Drumm. Musci Am. 9; Bartram. Mosses of Pima Co., Ariz. 1618, 151; Holz., Musci Acro. Bor. Am. 328; Herb. M. A. Howe 155.

On soil. Known in North America only from Arizona, California, and Saskatchewan.

3. *POTTIA TRUNCATA* (Hedw.) Fühnröhr, Flora 12²: 10. 1829.*Gymnostomum truncatum* Hedw. Spec. Musc. 30. 1801.*Gymnostomum truncatum* β minus Web. & Mohr, Taschenb. 81. 1807.*Gymnostomum circumcissum* Röhl. Ann. Wett. Ges. 2¹: 122. 1810.*Pottia truncata* Bruch, in Herb.; Fühnr. Flora 12²: 10. 1829.*Pottia eustoma* var. β *truncata* Hampe, Flora 20¹: 287. 1837.*Pottia eustoma* (Ehrh.) C. Müll. Synop. Musc. 1: 553. 1849.*Pottia truncatula* Lindb. De Tort. 220. 1864.*Tortula truncatula* Lindb. Musc. Scand. 21. 1879.

Gregarious to sod-forming; gametophyte up to 1 cm., usually 3–5 mm. high; stems with small central strand in upper portion, branched or simple; upper leaves *lanceolate to broadly lanceolate to spatulate, slenderly acuminate to acute*, widest at or above the middle, not abruptly narrowed to the insertion, *smooth to very slightly papillose on the lower side* in the upper half, 1–2.5 mm. long, shorter toward the base of the stem; costa strong, yellowish to reddish-brown, *typically excurrent into a smooth, stout, yellowish to brown awn*, rarely ending below the apex, in which case there is an apiculus of thin-walled cells; median cells chlorophyllose, 15–22 μ wide, with medium-thick walls, sometimes slightly collenchymatous (toward the margin commonly thicker-walled and slightly smaller), very irregular in shape—oblong to quadrate to hexagonal—somewhat smaller and rhomboidal toward the apex, progressively larger, thinner-walled and hyaline toward the base; at the base all hyaline, rectangular, up to 4–1; margins *plane or narrowly recurved to above the middle* (both conditions may occur on the same plant), entire below, *entire or more commonly serrulate to papillose by projecting transverse walls near the apex*, sometimes sparsely papillose with true papillae near the apex, rarely one or more cells projecting as teeth near the apex. Autoicous; antheridia up to 0.17 mm. long, occurring in a group with a few longer, hyaline, clavate paraphyses or naked in the axils of 1–2 minute, ecostate, ovate, acute leaves, located along the stem from near the base to near the stem tip; archegonia terminal, with no paraphyses; *sporophytes single or two or more from the same stem tip*; urn *gymnostomous*, erect, 0.4–0.79 x 0.4–1.1 mm., obovate before lid falls, *wide-mouthed and truncate afterward*, finely striate when dry; *neck short, rather indistinct*; stomata on the neck; lid erect or obliquely long-rostrate from a low-arched base; exothecial cells 23–40 μ wide, irregularly quadrate to oblong, 1 : 1 to 1 : 3, thick-walled; mouth bordered by 2–4 rows of smaller, rounded cells; annulus of 1–2 layers of small, very thick-walled, light-colored cells, persistent; *club-shaped, hyaline, 15–20 μ long, pectic filaments extending from each cell of the annulus when the operculum falls*. (Can be readily seen only when the operculum is carefully removed from the mature capsule under water); calyptra smooth, cucullate, covering about one-half the urn; seta with central strand, reddish-yellow, twisted to the right, 2–6.5 mm. long; spores reddish-brown to brown, finely papillose, 23–30 μ in diameter; mature from late autumn to spring. Type locality, Europe.

ILLUSTRATIONS:—Bryol. Eur. *pl.* 120; Dixon, Handb. Brit. Mosses (Ed. 3), *pl.* 22 K; Jenn. Mosses of Western Penn. *pl.* 13; Braith. Brit. Moss. Fl. 1: *pl.* 28 E; Grout M. H. M. *pl.* 33; *Pl.* 95.

EXSICCATI:—Austin, Musci. Appal. 111; Sull. & Lesq. Musci Bor. Amer. (Ed. 1) 90 and (Ed. 2) 116; Macoun, Can. Musci 154; part of Macoun, Can. Musci 62; E. G. Britton, N. Amer. Mosses 19, 99; G. N. Best, N. Amer. Mosses 52; E. B. Bartram, Flora of Penn. 941, 990, 991; Grout, Musci Perf. 216, 277; Holz. Musci Acro. Bor. Am. et Eur. 545.

On various substrates, from alluvial soil to old stone walls, where there is a plentiful supply of moisture. Frequently found on flood plains and wet meadows. In Canada, from Nova Scotia to the shores of Lake Huron; lower Michigan, western Pennsylvania and throughout eastern United States south to Maryland. A specimen from Indiana labeled *P. truncata* is *Weisia viridula*. Two specimens labeled *P. truncata* are known from Wisconsin; one is *Gymnostomum recurvirostrum*, one *Physcomitrium* sp. Specimens labeled *P. truncata* from Carson City, Nevada; Yale, British Columbia; Frazer River Valley, British Columbia; and Cascade Mountains, British Columbia are *P. nevadensis*. The first was collected by Sereno Watson and distributed under U. S. Geol. Ex. 40th Par. No. 1381; the rest were collected and distributed by Macoun. Macoun's Canadian Musci 62, collected on "Earth on limestone rocks, Gaspé Coast," labeled *P. truncata* Fühnr., requires some explanation. In the *Catalogue of Canadian Plants*, Part VI, pages 42 and 43, 1892, Macoun and Kindberg list the following:

(154.) *P. truncata*. . . Canadian Musci, No. 62 in part. On earth in fields, James Terrill's farm near Wooler, Northumberland Co., Ont. (*Macoun*.)

(155.) *P. intermedia*. . . *P. truncata*, Canadian Musci, No. 62, in part. On earth on the Portage between Lesser Slave Lake and Peace River, September 23rd., 1872. (*Macoun*.)

(156.) *P. litoralis* Mitt. . . . *P. truncata*, Canadian Musci, No. 62, in part. On earth at Yale, B. C., May 17th, 1875. (*Macoun*.)

There is no reference to any Gaspé Coast specimen, yet all the material distributed under No. 62 bore this designation. The material consists of at least three species: *P. nevadensis*, *P. truncata*, and *Desmatodon obtusifolius* (Schwägr.) Jur. The last, in the Farlow Cryptogamic Herbarium, has been relabeled as follows: "*P. riparia* Aust., corrected by Kindberg." No. 62 is apparently of diverse derivation and identification, and excepting No. 62, *P. nevadensis* is entirely Western, while *P. truncata* is entirely Eastern. It therefore seems reasonable to disregard this portion of the exsiccati in discussing distribution.

The author has not seen authentic North American specimens which might be placed definitely in *P. intermedia* (Turn.) Fűr. or in *P. litoralis* Mitt. These two species are probably varieties, or at best, subspecies of *P. truncata* and have been treated as such by various authors.

4. POTTIA TEXANA Wareham n. sp.

Plantae caespitosae, caule 0.5–1.0 mm. longo, ramis nullis. Folia erecta, superioribus 0.8–1.5 mm. longis, lanceolatis, sive brevius sive longius acuminatis; inferioribus brevioribus ovatisque; perichaetialibus non dissimilibus. Cellulae laminae superiores dense papillosae, plerumque quadratae, plerumque 12–15 μ latae; inferiores leves oblongae, 15–25 μ latae, usque ad 3 : 1. Margines laterales recurvatae, integerrimae. Costa crassa, ad 0.1 mm. excurrent, flavo-fusca. Paroicae, antheridiis nudis in foliorum superiorum axillis. Capsula deoperculata 0.5–0.7 mm. longa, ovata, fusca, gymnostoma, annulo deficiente, operculo breviter oblique-rostrato. Seta flavo-fusca 2–3 mm. longa, dextrorsum torta. Calyptra cucullata, dense scabra. Sporae dense papillosae, 23–31 μ diam. Differunt plantae ab *P. minutula* praecipue sporis non aculeis instructis.

Plants caespitose; stems without central strand, 0.5–1.0 mm. long, not branched; leaves tufted, erect to slightly incurved at the tips; upper leaves 0.8–1.5 mm. long, *lanceolate*, short- to long-acuminate; shorter and ovate below. Median cells 6–15 μ wide, *usually 12–15 μ , mostly quadrate* to slightly longer than wide, *conspicuously arranged in rows parallel to the margin*, fairly thick-walled, densely mammillate-papillose; marginal and apical cells not different; toward the base less papillose, longer and wider; basal cells thin-walled, 15–25 μ wide, up to 3 : 1; margins narrowly recurved from the base to or near the apex, entire except for papillae in upper half; costa yellowish-brown, up to 50 μ wide, densely papillose above, sparsely so or smooth below, excurrent into a stout, brownish awn up to 0.1 mm. long. Paroicous; antheridia 40–50 μ long, short-stalked, naked in the axils of the upper leaves. Archegonia terminal, naked; sporophytes single or in pairs; urn 0.5 to 0.7 mm. long, ovate, light brown; *gymnostomous*; not wide-mouthed when deoperculate; neck not distinct; stomata on capsule base; exothecial cells at middle of capsule very irregularly quadrate to rectangular, 12–40 μ wide, up to 3 : 1, fairly thin-walled; mouth bordered by 2–3 rows of darker colored, much smaller, thick-walled, quadrate cells; annulus not differentiated; lid *short-rostrate from an arched base*, over all up to 0.35 mm. high; seta yellowish-brown, with small central strand, 2–3 mm. long, twisted to the right; calyptra cucullate, covering about three-fourths of the urn, scabrous with many blunt papillae; spores densely papillose, almost opaque when mature, 23–31 μ in diameter. Type locality, near St. Marcos, Texas.—*C. Wright*. Distributed by Sullivant and Lesquereux as *P. minutula* Bryol. Eur.

ILLUSTRATIONS:—Pl. 93.

EXSICCATI:—Sull. & Lesq. Musci Bor. Am. (Ed. 1) 91, (Ed. 2) 117, issued as *P. minutula* (the TYPE).

By the appearance of the substrate, on sandy soil. No habitat data are given on the label. This species differs from *P. minutula** principally in having low-papillose rather than echinate spores. It is distinguished from *P. arizonica* by almost opaque spores, larger leaf cells, and lanceolate leaves. St. Marcos can not be located but it may be the San Marcos of present day maps, located some 50 miles north and east of San Antonio.

5. POTTIA STARKEANA (Hedw.) C. Müll. Synop. Musc. 1: 547. 1849.

Weisia Starkeana Hedw. Spec. Musc. 65. 1801.

Bryum minutulum Dicks. Plant. Crypt. Brit. 4: 3, pl. 10, fig. 17. 1801.

Anacalypta Starkeana Bruch in Herb.; Fűr. Flora 12: 35. 1829.

Desmatodon Starkii Hüb. Muscol. Germ. 109. 1833.

Desmatodon Starkii De Not. Syll. 205. 1838.

Tortula Starkei Lindb. Musc. Scand. 21. 1879.

Plants caespitose; stems with small central strand, usually unbranched, 1–2 mm., usually about 1 mm. long; leaves tufted; upper ones ovate to ovate-lanceolate, acute to short-acuminate, up to 1.5 mm. long;

* *P. minutula* (Schleich) Bry. Eur. = *P. rufescens* (Schultz) Warnst. = *P. Davalii* (Sm.) n. comb. = *Gymnostomum Davalianum* Sm., Kon. Sims Ann. Bot. 1: 577. 1805. (According to Lindberg.)

shorter and ovate below; perichaetial leaves not differentiated; median cells usually thin-walled, irregularly quadrate to hexagonal, 7–11 μ wide, densely mammillate-papillose; marginal and apical cells not different; toward the base progressively larger, more rectangular, and less papillose; cells at base thin-walled, hyaline, rectangular, 15–25 μ wide, up to 3 : 1; margins narrowly recurved from the base to or near the apex, entire except for papillae in upper half; costa yellow to reddish brown, papillose both sides, area of thick-walled cells 35–45 μ wide, percurrent to excurrent in a short, stout mucro. Paroicous; antheridia naked in the axils of the upper leaves; archegonia terminal, with thread-like paraphyses or naked; sporophyte single; urn ovate to long ovate, brown to reddish-brown, 0.7–1.0 mm. long, usually about 0.8–0.9 mm., not wide-mouthed when deoperculate; neck not distinct; stomata at base of capsule; exothecial cells thin-walled, 15–25 μ wide, irregularly rectangular at middle of capsule; mouth bordered by 2–4 rows of thick-walled, smaller cells; annulus not differentiated; lid short-conic to hemispheric; peristome of 16 yellowish-brown, very densely papillose, 0.65–0.163 mm. long, imperfect, narrowly lanceolate and pointed to rather broad and truncate, sometimes irregularly perforate teeth on a low basal membrane; calyptra cucullate, covering about one-half the urn, scabrous with numerous blunt papillae; seta with small central strand, 2–4 mm. long, usually about 3 mm., yellow to reddish, twisted to the right or left; spores yellow, tetrahedral, quite regularly tuberculate by large, rounded emergences on the curved face, not papillose, 21–30 μ in diameter; mature in late winter to early spring. Type locality, Europe.

ILLUSTRATIONS:—Bryol. Eur. 2: pl. 125, except the spores; Dixon, Handb. Brit. Mosses (Ed. 3) pl. 23G; Braith. Brit. Moss. Fl. 1: pl. 29C; Pl. 90.

EXSICCATI:—Sull. & Lesq. Musci Bor. Am. (Ed. 2) 119. This collection also contains material which may be referred to *P. arizonica*; Howe, Musci Californici 79.

On soil. All the specimens seen have been collected in southern California. One specimen reported from "Utah (Watson)" in Lesquereux and James Manual, 103, 1884, has not been seen. Since Lesquereux and James do not mention spore characters it is possible that this specimen was misidentified. Warnstorff in Hedwigia, 1916 lists Sull. and Lesq. 119 in his exsiccati of *P. mutica*. It is possible that the material he examined is that portion which in this monograph is referred to *P. arizonica* (see note under that species).

6. POTTIA ARIZONICA Wareham n. sp.

Plantae caespitosae, humiles, caule plerumque 1 mm. longo. Folia collata, apicibus patulis vel prope recurvatis, concava, plerumque aliquantulum asymmetrica. Folia superiora 1.0–1.3 mm. longa et 0.5–0.6 mm. lata, ovato-oblonga, breviter-acuminata; folia perichaetalia non dissimilia. Cellulae laminae superiores sexangulares vel quadratae, dense papillosae, 7–13 μ latae; inferiores quadratae vel oblongae, 18–23 μ latae, raro plus quam 2 : 1. Margines laterales revoluti-recurvatae, integerrimae. Costa crassa, 0.06–0.26 mm. excurrens, flava. Paroica, antheridiis nudis in foliorum superiorum axillis. Capsulae plerumque paulo inaequales, deoperculatae 0.9–1.2 mm. longae et ore coarctatae, fuscae; collo maturo subdistincto, annulo deficiente, operculo breviter-conico vel oblique longe-conico, peristomii dentibus 16, imperfectis, plerumque truncatis, papillosis, 60–130 μ longis, fusculo-flavis, in membrana basilari angusta. Seta flava vel rufulo-flava ad 5 mm. longa, flexuosa, dextrorsum torta. Calyptra cucullata, scabra. Sporae flavae, 18–25 μ diam., leves vel papillis minoribus et pustulis minoribus vel pustulis magnis instructae. Differunt plantae ab *P. mutica* sporis non aculeis instructis, peristomio maiore, et costa longe-excurrente.

Plants caespitose; stems 1–3, mostly about 1 mm. long, with central strand, simple or sometimes with one branch, bearing rhizoids below the leaves only; leaves tufted, crowded, as a rule wide-spreading to almost squarrose at the tips when moist, somewhat concave, mostly somewhat asymmetric, not lying flat when removed; upper leaves 1.0–1.3 mm. long by 0.5–0.6 mm. wide, mostly ovate-oblong, short-acuminate; progressively smaller toward the base of stem, lowest ones ovate; perichaetial leaves not differentiated; median cells mostly hexagonal, sometimes quadrate, 7–13 μ in diameter, walls thin to fairly thick, chlorophyllose, thickly papillose on both sides with mammillose and branched papillae; marginal and apical cells not different; cells toward the base progressively less papillose, larger and more rectangular; basal cells 18–23 μ wide, thin-walled, mostly quadrate to oblong, seldom more than 2 : 1; margins mostly narrowly to broadly revolute from base to apex or near it, entire except for papillae in upper half; costa yellow to reddish-yellow, area of thick-walled cells 20–30 μ wide, papillose on both sides in upper half of leaf, on some leaves of each plant excurrent into a yellowish awn 0.06–0.26 mm. long. Paroicous; antheridia 0.13–0.15 mm. long, short-stalked, naked in the axils of the upper leaves; archegonia terminal, naked; occasionally a branch bearing archegonia occurs; sporophytes single or paired; urn usually slightly unsymmetrical, 0.9–1.2 mm. long, ovate to long-elliptic, golden brown, narrowed at the mouth when deoperculate; neck fairly

distinct when mature, stomata numerous, on the neck; annulus not clearly differentiated; mouth bordered by 2-4 rows of thick-walled, usually quadrate cells; exothelial cells at middle of capsule 20-30 μ wide, quite regularly rectangular, a little over 2 : 1, quite thin-walled on the outside, thick-walled inside; lid conic to long-conic, mostly oblique; *peristome of 16 teeth from a low basal membrane, imperfect, usually truncate, irregularly divided, very papillose, brownish-yellow, 60-130 μ long*; seta with small central strand, yellow to reddish-yellow, about 5 mm. long, flexuose, twisted to the right; vaginula conic, frequently unsymmetric; calyptra cucullate, scabrous with low, blunt papillae, covering one-half to three-fourths of the urn; spores 18-25 μ in diameter, irregular in shape, sometimes somewhat tuberculate, *finely papillose to smooth, thin-walled, yellow, almost transparent*; mature in late January to March. Type locality, shaded banks of dry wash, Tucson Mts., Pima Co., Arizona.—E. B. Bartram. Type specimen in herbarium of E. B. Bartram, Bushkill, Penn.

ILLUSTRATIONS:—Pl. 95.

EXSICCATI:—Bartram, Mosses of So. Ariz. 989 in part (this collection bearing the original label, *Pottia mutica* Vent., has been designated the TYPE); l. c. 744; Bartram, Mosses of Pima Co., Ariz. 990, 990B; Crypt. Coll. John Leiberg 1177, 1166; Holz., Musci Acro. Bor. Am. et Eur. 572 as *P. mutica* Vent. (This is part of Bartram, Mosses of Pima Co. Ariz. 990 and contains both the species and the variety); Sull. and Lesq., Musci Bor. Am. 119 in part, distributed as *P. Starkeana*.

On soil, Arizona and southern California. This species differs from *P. mutica* by a much larger peristome, costa excurrent into an awn and appearing much narrower because of a fewer number of thick-walled cells, more elliptical capsule, usually longer lid, smoother calyptra, and absence of small spines on the spores; from *P. caespitosa* by its parvicous sexual condition and rough calyptra; from *P. Wilsoni* by larger peristome and smoother calyptra; from *P. Starkeana* by less regularly tuberculate, papillose spores, longer capsule, longer lid, and broader leaves with longer awns.

6a. Var. MUCRONULATA Wareham n. var.

Plantae a specie nullo modo differunt nisi ut costae subpercurrent vel breviter excurrent; foliis plerumque symmetricis pauloque minoribus; peristomio deficiente vel in brevi membrana basilari consistente; operculo plerumque obtuse conico.

Similar to the species with the following exceptions: costa subpercurrent to excurrent in a short mucro; leaves as a rule more symmetric and a little smaller; peristome lacking to consisting of a short basal membrane and operculum usually blunt-conic. Type locality, Tucson Mts., Pima Co., Arizona.—E. B. Bartram. Type specimen in herbarium of E. B. Bartram, Bushkill, Penn.

ILLUSTRATIONS:—Pl. 95.

EXSICCATI:—Bartram, Mosses of So. Ariz. 985 (the TYPE) and many other collections under this label as well as under the label, Mosses of Pima Co., Ariz.; Holz. Musci Acro. Bor. Am. 520 as *P. mutica* var. *gymnostoma* Corb. (This is the same collection as Bartram 747.)

Occurring on soil in pure stands or mixed with the species. Arizona and southern California. Most of the American material labeled *P. mutica* Vent. can be placed in *P. arizonica* or its variety. However, a few specimens have been seen having percurrent costae and a good peristome or awned leaves and a gymnostomous capsule. These plants may represent hybrids. *No American specimens of Pottia having echinate spores have been seen.* Warnstorff, in Hedwigia 1916, lists Sull. and Lesq. Musci Bor. Am. 119 in his *P. mutica* exsiccati. He also lists Erbar. Critt. Ital. Ser. II No. 160 from Triente, Switzerland. Several examples of the latter collection have been seen. The spores are invariably possessed of small spines.

7. POTTIA RANDII Kennedy, Rhodora 1: 78-80. 1899.

Plants caespitose, up to 15 mm. in height over all; stems without central strand, up to 3 mm. long, seldom branched; leaves tufted, erect; upper leaves *smooth except for occasional mamilliose papillae in upper part, oblong to broadly spatulate, short-acuminate*, up to 4 mm. long by 1 mm. wide, usually about 3 x 1 mm., slightly concave; progressively shorter toward the base of stem; two or three next to the archegonia smaller than the tufted ones, entire; cells just above the middle chlorophyllose, oblong to rhomboidal, 15-20 μ wide, mostly about 2 : 1; toward the apex almost square to rhomboidal; progressively longer and wider and hyaline toward the base; a few just above the insertion somewhat inflated; margins entire below, serrulate to serrate from above the middle to the apex; narrowly recurved and 2-3 cells thick from the base to just above the middle, plane at apex; bordered in lower half by 3-6 rows of linear, thick-walled, elongated cells; in upper half to near the apex by elongated, rhomboidal cells; costa strong, percurrent to very shortly excurrent. *Autoicous; antheridia long-stalked*, measuring over all about 0.7 mm., the stalk sometimes equalling the tube in length; borne among many somewhat clavate paraphyses, located in the axil of a small,

0.7–1.1 mm. long, costate leaf very near the archegonial tip; archegonia at the tips of the main stem, among numerous paraphyses. Sporophyte usually single, occasionally two occurring together; urn ovate, *unsymmetric, somewhat arcuate*, 0.6–1.3 mm. long; when dry and empty smooth, not wide-mouthed, sometimes slightly contracted below the mouth; neck distinct; stomata on the neck; exothecial cells irregularly quadrate to oblong, 15–20 μ wide, up to 2 : 1, medium thick-walled; annulus of 1–2 layers of very thick-walled, quadrate cells, persistent; *peristome none*. Lid usually oblique, long-conic from an arched base; calyptra smooth, cucullate, covering one-half to three-fourths of the urn; seta with small central strand, 7–10 mm. long, flexuose, yellowish-red, *twisted to the right below and to the left above*; spores 24–36 μ in diameter, irregularly shaped, yellowish-red, warty-papillose; mature in early summer. Type locality, Baker Island, near Mt. Desert, Maine.—*Rand*, July 15, 1898.

ILLUSTRATIONS:—*Rhod*. 1: 80. *pl.* 5. 1890; *Pl.* 94.

EXSICCATI:—*Herb. Geo. Kennedy* at Farlow Crypt. Herb. (The TYPE. A portion of the type is also located at the New York Botanical Garden); *Grout*, *Musci Perf.* 197.

Only three collections are known from North America. The type from Baker Island grew "among stones in sand by the seashore." *Grout's* 197 was collected by W. S. Flowers on soil in shade, Washington Park, Chicago, Ill. The three collections certainly represent the same species. *Matinicus*, Maine (*Norton*).

Holzing in *Bryol.* 28: 6, 1925 presents evidence that *P. Randii* is really a gymnostomous form of *Desmatodon cernuus*. In Europe, where several collections have been made, the species is called *Desmatodon Randii*. Although *P. Randii* and *D. cernuus* are remarkably similar in many respects *P. Randii* has no trace of a peristome, much smoother leaves which are shorter acuminate, and a less excurrent costa. The similarity to *D. cernuus* in leaf and stem cross section, cell shape and disposition, calyptra, lid, and seta is very striking. In the author's opinion, it is quite possible that the species should be treated as a *Desmatodon*.

8. POTTIA LANCEOLATA (Hedw.) C. Müll. Syn. Musc. 1: 548. 1849.

Encalypta lanceolata Hedw. Spec. Musc. 63. 1801; and *Bry. Eur. pl.* 127. 1843.

Dicranum latifolium Turn. Musc. Hibern. 79. 1804.

Weisia aciphylla Wahlenb. in Vet. Akad. Nya Handl. 27: 133. *pl.* 4, *fig.* 1. 1806.

Grimmia aciphylla Web. & Mohr, Taschenb. 137 and 457. 1807.

Weisia lanceolata Röhl. Deutsch. Fl. (Ed. 2) (3): 51. 1813.

Coscinodon lanceolatus Brid. Musc. Recent. Suppl. 4: 49. 1819; and *Bryol. Univ.* 1: 372. 1826.

Coscinodon aciphyllus Brid. Musc. Recent. Suppl. 4: 49. 1819; and *Bryol. Univ.* 1: 373. 1826.

Coscinodon connatus Kaulf. Mscr. in Brid. Musc. Recent. Suppl. 4: 50. 1819; and *Bryol. Univ.* 1: 374. 1826.

Weisia connata Wallr. in Comp. 3: 142. 1831.

Dermatodon lanceolatus Hüben. Musc. Germ. 112. 1833.

Desmatodon lanceolatus Bruch, Mscr.; De Not. Syll. 205. 1838.

Tortula lanceolata Lindb. Musc. Scand. 21. 1879.

Sod-forming; stems 2–5 mm. high, with central strand, sometimes branched, usually simple; upper leaves up to 2 mm. long, *broadly lanceolate to more or less oblanceolate*, short- to long-acuminate, keeled, twisted when dry; progressively shorter toward base of stem; median cells chlorophyllose, 12–17 μ wide, irregularly quadrate to hexagonal, *sparingly to quite densely mammillate papillose* on both sides, thin to quite thick-walled and slightly collenchymatous; somewhat smaller toward the apex; toward the base progressively longer and a little wider, smooth, thinner-walled; at the base oblong, up to 5 : 1, one or more rows at the insertion yellowish and somewhat inflated; *margins ordinarily recurved from the base to or very near the apex*, entire at base, serrulate from middle to apex by projecting transverse walls, sometimes papillose near the apex; costa strong, yellowish, *excurrent into a stout, yellowish, usually smooth to serrulate awn 1/10 to 1/3 as long as the lamina, covered on the upper side with enlarged irregularly-quadrate, thin to thick-walled, very papillose cells*, smooth or sparingly papillose below. Autoicous; antheridia up to 0.22 mm. long, naked at the tips of very short basal branches tufted with minute, ecostate leaves or in the axils of stem leaves with a few slender, hyaline paraphyses. Archegonia at the tips of main stems or branches; sporophytes single or in pairs; urn up to 1.6 mm. long, reddish-brown, erect, ovate, to narrowly elliptical, irregularly wrinkled and *contracted below the mouth when dry*; not wide-mouthed when deoperculate; neck short but distinct; stomata few, between the neck and the urn; exothecial cells 18–39 μ wide, thin- to thick-walled, irregularly quadrate to oblong; mouth bordered by 3–6 rows of smaller, rounded to quadrate, in-

crassate cells; annulus irregular, of 1-2 rows of very thick-walled pale yellow cells; peristome of 16 very papillose teeth from a low basal membrane, up to 0.32 mm. long, yellowish, inserted just below the mouth; teeth irregularly developed, with a distinct divisural line, *usually cleft at the apex and often perforate*; lid obliquely long-conic to rostrate from a *high-arched base, cells steeply spiraled to the left*; calyptra smooth, cucullate, covering one-half to three-fourths of the urn; seta yellowish-red, with central strand, 4-9 mm. long, *twisted to the right below and to the left above*; spores 18-26 μ in diameter, finely warty-papillose, reddish-brown; mature in spring. Type locality, Europe.

ILLUSTRATIONS:—Bry. Eur. l. c.; Dixon Handb. Brit. Mosses, (Ed. 3) *pl.* 23*J*; Braith. Brit. Moss Fl. 1: *pl.* 29*A*; Pl. 97.

EXSICCATI:—Leiberg, Mosses of Kootnai Co., Idaho as *P. Wilsoni*; Crypt. Coll. John Leiberg presented to U. S. Nat. Museum 264.

The first collection named above bears the following data, "On the ground Cp. Horn Mt. at 3500 ft. alt., Mch. 27, 1890"; the second, "Broken soil, south end of Lake Pend Oreille, Idaho." These are the only collections known from North America.

9. POTTIA NEVADENSIS Card. and Thér. Bot. Gaz. 37: 365. *pl.* 18, *figs.* 1^{a-e}. 1904.

Sod-forming; stems with central strand surrounded by a layer of brown cells, erect, simple or branched, 1-3 mm. high; *upper leaves erect, imbricated, not papillose, very concave, ovate to obovate, short acuminate to blunt*, up to 2.5 mm., usually about 2 mm. long, up to 2 mm. wide; shorter below and relatively narrower; median cells sparingly chlorophyllose, thin-walled, irregularly rhomboidal, about 15 μ wide by 30 μ long, toward the apex usually smaller; toward the base progressively larger and less chlorophyllose; extreme basal cells hyaline, thin-walled, oblong, up to 30 μ wide, about 3-1; *margins plain or slightly inrolled* (the original description says "saltem uno latere parce revolutis"), on some leaves entire but *some of the upper leaves of nearly all plants irregularly toothed by projecting rhomboidal cells*; costa yellowish-brown, mostly excurrent into a smooth, slender awn, occasionally ending below the apex. Autoicous; antheridia 0.39 mm. long, among slender, hyaline, 0.52 mm. long paraphyses, each tipped with a cone-shaped, pointed cell, *borne terminally on a short, leafy, basal branch* tufted with minute, up to 1 mm. long, serrate, costate leaves. Archegonia terminal, naked; sporophyte single; urn *gymnostomous, erect, long-ovate*, 0.7-0.9 x 1.2-2.0 mm., not wide-mouthed when deoperculate; *neck short but distinct*; stomata on the neck; lid obliquely rostrate from an arched base, *attached to columella*; exothecial cells thick-walled, mostly irregularly oblong, 15-23 μ wide, 1 : 2 to 1 : 3 at middle of capsule; mouth bordered by 1-4 rows of much smaller, transversely-elongated cells; annulus of 1-2 rows of small, almost round, very pale yellow, thick-walled cells, persistent; calyptra smooth, cucullate, covering about one-half the urn; seta with central strand, pale yellow to yellowish-red, *twisted to the left*, 8-12 mm. long; spores very finely papillose, reddish-brown, 19-31 μ ; ripe in late spring to early summer. Type locality, Ormsby Co., Nevada.—C. F. Baker.

ILLUSTRATIONS:—Bot. Gaz. 37: l. c. Pl. 93.

EXSICCATI:—C. F. Baker, Plants of Nevada 959 (the TYPE or COTYPE); Holzinger, Musci Acro. Bor. Am. 155; Macoun, Flora Can. 220, as *P. intermedia*, 111 as *P. truncata* var. *subcylindrica* and Can. Musci 330 as *P. litoralis*; many specimens of Macoun, Can. Musci 62, as *P. truncata* (see notes below); Flowers, Flora of Utah 1200; U. S. Geol. Ex. 40th Par. 1381 as *P. truncata*.

Flowers' collection was made on "dry, saline soil, east shore of Great Salt Lake." None of the other collections bear habitat data other than "on earth" except Macoun's 62 from the Gaspé Coast. Material distributed under this number was apparently collected in three parts of Canada (see notes under *P. truncata*), and it seems to be almost impossible, at this date, to be sure of their origin. In Mitten's Herbarium, now at New York Botanical Garden, a packet of Can. Musci 62 labeled *P. litoralis* is *P. nevadensis*. The distribution seems to be definitely Western. Specimens of unquestionable origin are known only from Utah, Nevada; British Columbia, and either Saskatchewan or Alberta in Canada. The location of the latter is simply "Athabaska Plains."

10. POTTIA HEIMII (Hedw.) Fűr. Flora 12²: 10. 1829.

Gymnostomum Heimii Hedw. Spec. Musc. 32. 1801.

G. obtusum Turn. Musc. Hib. 9, *pl.* 1. 1804.

G. affine Bryol. Germ. 1: 140. *pl.* 9, *fig.* 9. 1823.

Pottia affinis Fűr. Flora 12²: 10. 1829.

P. Heimii var. β *cylindrica* Bry. Eur. *pl.* 124. 1843.

P. Heimiioides Kindb.; Macoun Cat. Can. Pl. 6: 43. 1892.

Didymodon heimii Kindb. Europ. and N. Amer. Bryin. 280. 1897.

D. Heimii (Hedw.) Kindb. l. c.

Desmatodon systilioides Ren. & Card. Bot. Gaz. 30: 16. 1900.

Pottia Heimii var. *beringiana* Card. & Thér. Proc. Wash. Acad. Sci. 4: 301, pl. 14, figs. 2^{a-i}. 1902.

Forming sod up to 8 mm. deep; stems with a large central strand, radiculose at base, branched or simple; upper leaves erect, imbricated to somewhat spreading, 2.5–3.3 x 0.52–1.0 mm., ovate to ovate-lanceolate to long-lanceolate, short-acuminate to long-acuminate or acute, strongly concave, somewhat keeled; median cells usually almost obscured by many so-called c-shaped papillae on both sides, occasionally nearly smooth, hexagonal to rounded-quadrate, thick-walled, 9–20 μ wide; basal cells much larger, smooth, lax, thin-walled, hyaline, rather sharply distinguished from the median; leaves usually bordered above by 2–5 rows of sometimes thicker-walled, oblong to rhomboidal, less papillose, yellowish cells; bordered below by 2–4 rows of very narrow, elongated cells; margins plane, entire below, papillose at middle, and usually more or less toothed by projecting transverse walls or by projecting cells at apex; costa strong, subpercurrent to short-excurrent; leaves progressively shorter, broader in proportion to the length and less differentiated toward the base of stem. *Polyoicous*; archegonia and antheridia borne terminally; purely male stems or branches bearing 0.26–0.34 mm. long antheridia among many, almost clavate paraphyses, each tipped with a cone-shaped, pointed cell; purely female stems or branches bearing a few archegonia and occasionally a few paraphyses; bisexual stems or branches bearing both archegonia and antheridia and a few paraphyses; seta with central strand, yellow to reddish brown to red, 4–16 mm. long, twisted to the left for most of the upper length, sometimes to the right at the base; calyptra cucullate, smooth, falling early, covering about one-half the urn; urn ovate to long-cylindric, 1.0–2.7 x 0.5–0.9 mm., not wide-mouthed when deoperculate, *gymnostomous*, neck short, distinct; stomata on the neck; lid conic to long-rostrate from a high-arched base, erect or oblique, *systylous*; exothelial cells at middle of capsule quadrate to oblong, 1:1 to 1:6, 15–30 μ wide, medium thick-walled; mouth bordered by 1–3 layers of smaller, rounded-quadrate cells; annulus of 1–2 layers of small, rounded, very thick-walled cells, persistent either on the lid or the capsule mouth; spores yellowish to reddish-brown, papillose, 19–39 μ in diameter; mature in late spring. Type locality, Europe.

ILLUSTRATIONS:—Bryol. Eur. pl. 124, incl. varieties; Warnst. in Hedwigia 58: 96–100, figs. 17, 18, 19, 20, 21; Dixon Handb. Brit. Mosses (Ed. 3) pl. 22J; Braith. Brit. Moss Fl. 1: pl. 28D; Pl. 97.

EXSICCATI:—Canadian Musci 577 (some of the material distributed under this number is *Didymodon recurvirostris*); U. S. Geol. Explor. of 40th Parallel under Clarence King 1382; Sull. and Lesq. Musci Bor. Am. (Ed. 2) 115 (usually mixed with *Didymodon recurvirostris*); Mosses of Colorado Dist. by J. M. Holzinger (Not numbered. Some material distributed under this label is *Tortula* sp.); Palliser's Brit. North Amer. Expl. Exped. Rocky Mts. (as *Desmatodon Heimii*, no number); Drumm. Musci Am. 13, 14, 15; Plantae Groenlandicae from Western Greenland (No number. This approaches the var. *obtusifolia*); Alaska Musci—Kincaid 47, 51 as the var. *beringiana*; The Harriman Alaska Expedition—Trelease 2151 as var. *beringiana*; U. S. Nat. Herb., Mosses of Yellowstone Nat. Park (not numbered).

Usually on moist alkaline and saline soils, frequently a sea coast plant. In North America known from New Mexico, Colorado, Utah, Wyoming, Montana, Idaho, Washington, Alberta, Ontario, Newfoundland, Northwest shore of Hudson's Bay, St. Paul and St. Matthew Islands in the Bering Sea, and Greenland. This is truly a portean species. Many varieties and forms have been described. Warnstorff in Hedwigia l. c. left nothing in the species but referred all specimens to 13 varieties and 2 forms, based principally on leaf form and shape. It is, however, almost, if not quite impossible to draw any lines which will sharply delimit these varieties. In the same colony and often on the same plant may be found leaves bordered and non-bordered, with toothed and nearly entire margins, densely papillose to almost smooth. One specimen examined was quite papillose on one side of the costa while the cells on the other side were nearly smooth. In the same colony may be found ovate to long-cylindric capsules, long and short setae. There seems to be no consistent relation between the length of the setae and the shape and size of the capsules, i. e., long setae and short capsules, long setae and long capsules, short setae and long capsules, short setae and short capsules occur. Moreover, these variations in the sporophyte occur with various leaf shapes and sizes. Even the variety *obtusifolia*, which in some collections is very distinct, may possibly be an ecological variation or a hybrid segregate. A series grading from the long-acuminate form to the very obtuse form may be prepared easily. Collections having broadly obtuse and acute leaves on the same plant have been seen.

P. heimii Kindb. in Macoun, l. c., described as resembling *P. Heimii*, but differing principally in having a rudimentary peristome, was probably based on the gametophyte of *P. Heimii* and old capsules of *Didymodon recurvirostris* (Hedw.) Jenn. Both species have been found associated in specimens named by Kindberg and cited by Warnstorff l. c., who illustrated *P. heimii* Kindb., p. 125, fig. 42. Warnstorff states that Sull. and Lesq., Musci Bor. Am. 115, in the herbarium at Berlin as *P. Heimii*, is *P. heimii* Kindb. This number in the New York Botanical Garden is a mixture of *P. Heimii* and *D. recurvirostris*. In the Ohio State University herbarium it is a mixture of *P. Heimii* and *Tortula* sp. In none of the dozen or so specimens named *P. heimii* Kindb. in the various herbaria in the United States and Canada were any peristomate specimens found. The name must be relegated to synonymy.

10a. Var. *OBTUSIFOLIA* (R. Brown) Hagen in Musci Norv. Bor. 45. 1899.

Gymnostomum obtusifolium R. Brown Suppl. append Itin. Parryan. 299. 1824; and Schwäg. Suppl. 2^o: 82. 1826.

Pottia obtusifolia C. Müll. Synop. Musc. 1: 556. 1849. (Not p. 559.)

P. Heimii var. *arctica* Lindb. in Öfvers. K. Vet. Akad. Förh. 23: 551. 1866.

P. Ryani Philib. in Rev. Bryol. 23: 28. 1896.

Didymodon Heimii Ryani Kindb. in Europ. and N. Amer. Bryin. 280. 1897.

Pottia papillosa Harmsen in Meddel. om Grøn. 82^o: 24. 1932.

Plants gregarious or cespitose; leaves erect, usually shorter than the species, very concave to cucullate, orbicular, ovate, oblong or lingulate, with apices rounded to short-apiculate; margins mostly entire to crenulate, sometimes weakly toothed; costa ending below the apex or in the apiculus; urn ovate to short-cylindric, up to 1.5 mm. long, sometimes wide-mouthed when deoperculate; lid short-conic to obliquely short-rostrate. Type from Melville Island. Specimen in Schwärchen's Herbarium.

ILLUSTRATIONS:—Schwäg. l. c. *pl.* 176; Harmsen l. c.; Warnstorff in Hedwigia 58: 100–101, *figs.* 22, 23. 1916.

EXSICCATI:—Acad. Sci. Phila., Exped. to Green. in 1891. (Portions of the collection bearing the label *P. Heimii* var. *arctica* are this variety. It is mixed with *P. Heimii*); Herb. Geol. Sur. Can. Arctic Exped. in 1913–1916, Cape Bathurst, Canada. Coll. Frits Johansen, July 26, 1916. (This specimen has some acute leaves but is pretty good var. *obtusifolia*.)

On soil, in pure stands or with the species. All our collections are from the Arctic Region: Cape Bathurst, Northwest Territories; Melville Island; and Whale Sound, Greenland.

11. *POTTIA LATIFOLIA* (Schwägr.) C. Müll. Syn. Musc. 1: 549. 1849.

Weisia latifolia Schwägr. in Schultes Reise Grossglockner Append. to Vol. 4. 1804; and Schwägr. Suppl. 1: 64. *pl.* 18. 1811.

Grimmia latifolia Web. & Mohr, Taschenb. 147. 1807.

Anacalypta latifolia Fühnr. in Flora 12^o: 25. 1829.

Dermatodon latifolius Hübner. Muscol. Germ. 116. 1833.

Desmatodon bulbosus De Not. Syllab. 203. 1838.

Didymodon bulbosus Hartm. Skand. Fl. (Ed. 4) 382. 1843.

Pottia (Hyalophyllum) pilifera β *mutica* Lindb. de Tort. 223. 1864.

Tortula bullata β *mutica* Lindb. Musc. Scand. 21. 1879.

Segonia latifolia Vent. in Rev. Bryol. 10: 96. 1883.

Hyalophyllum latifolium (Schwägr.) Warnst. in Hedwigia 53: 284. 1913.

In loose clusters or forming sods, *bulbiform*, light green to silvery; stems with large central strand, 1–2 mm. long, usually branched at base; *upper leaves imbricated, smooth, apiculate to obtuse, broadly oval, with a narrower, sheathing base*, up to 2 mm. long; progressively shorter toward the base, the lowest ones orbicular or wider than long; leaves under low magnification *appear to be divided transversely at about the middle into a small-celled, yellowish portion above and a hyaline, large-celled portion below*; cells of the upper half irregularly rhomboidal, 9–15 μ broad, up to 2 : 1, thin-walled to incrassate, containing very few, small chloroplasts; *walls on the under side very thick*, up to 11 μ , yellow; upper walls thin; cells at the apex smaller, incrassate, often colorless; cells of the lower half irregularly oblong, 15–30 μ wide, up to 4–1, walls yellow and of the same thickness on all sides; margins usually plane, occasionally narrowly recurved, entire below, entire or serrulate near the apex; costa yellowish, usually ending several cells below the apex. Autoicous; antheridia 0.32–0.35 mm. long, at the tips of leafy, basal branches; paraphyses few or none, very slender, hyaline; archegonia few, terminal; sporophytes single; urn brown, 1.1–1.8 mm. long, erect, symmetrical to slightly arcuate, oval to long-elliptic, narrowed at the mouth, usually contracted below the mouth and irregularly wrinkled when dry; seta with central strand, 4–10 mm. long, yellow to brownish red, twisted to the right below and to the left above; exothecial cells thick-walled, irregularly oblong, 15–31 μ wide, up to 4 : 1 at middle of capsule, shorter above and below; mouth bordered by 1–4 rows of smaller, incrassate, darker colored cells; neck tapering, rather indistinct; stomata on the neck; annulus of 1–3 rows of lighter colored, irregularly shaped, very thick-walled cells, persistent; lid obliquely short- to long-rostrate, from a low-arched base; peristome of 16 narrow, papillose, yellow-brown teeth, 0.16–0.23 mm. long, split at the apex and often perforate along the divisural line; basal membrane very low, not appearing above the mouth;

calyptra smooth, cucullate, covering about one-half the urn; spores 33–48 μ in diameter, finely warty-papillose, reddish-brown; mature in spring and early summer. Type locality, Switzerland.

ILLUSTRATIONS:—Bry. Eur. *pl.* 128; Schwägr. Suppl. l. c.; Dixon Handb. Brit. Mosses (Ed. 3) *pl.* 23K; Braith. Brit. Moss Fl. *pl.* 30B; *Pl.* 95 & 96.

EXSICCATI:—Drumm. Musci Bor. Am. 70; Macoun, Can. Musci 162; U. S. Geol. Ex. of 40th Par. 138. Bayard Long, Mosses of Newfoundland 373.

On soil or rocks. Considered to be Arctic and Alpine in distribution. Colorado, Wyoming, Nevada in the United States; Rocky Mountains in Canada; St. Johns; Greenland. The following collections have been erroneously called *P. latifolia*: Canadian Musci Ex. Herb. Geol. Survey, 158 is *Desmatodon latifolius*; and Cryptogamic Coll. John Leiberg, presented to U. S. Nat. Museum, 329 is *Pterigoneurum ovatum*.

11a. Var. *PILIFERA* (Brid.) C. Müll. Syn. Musc. 1: 550. 1849.

Coscinodon pilifer (Funck) Brid. Bryol. Univ. 1 (Suppl.): 810. 1826.

Dicranum bullatum Sommerf. Suppl. Fl. Lapp. 1826.

Weisia pilifera Funck, Mscr. in Wallr. Comp. 3: 149. 1831.

Anacalypta latifolia β *pilifera* Bryol. Germ. 2^o: 137. 1831.

Dermatodon Funckii Hübner. Musc. Germ. 115. 1833.

Pottia (*Hyalophyllum*) *pilifera* Lindb. de Tort. 223. 1864.

Tortula bullata Lindb. Musc. Scand. 21. 1879.

Hyalophyllum latifolium var. *piliferum* (Brid.) Warnst. in Hedwigia 53: 284. 1913.

Like the species except that the costa is excurrent into a hyaline, piliferous awn from 0.5 to 1.5 mm. long and from one-fifth to as long as the lamina.

ILLUSTRATIONS:—Bryol. Eur. *pl.* 128. *Pl.* 95.

EXSICCATI:—Drumm. Musci Am. 70; Williams, Plants of Yukon Territory 564.

In pure stands or with the species. Rarely specimens occur having shorter awns than is the rule and having both awned and non-awned leaves on the same plant. Known from Alaska and from the Rocky Mountains in Canada.

4. *PTERIGONEURUM* Juratzka, Laubmfl. Oesterr.-Ung. 95. 1882.*

R. T. Wareham

Plants small, forming convex sods or expanded turfs, usually gray-green because of the hyaline hair-points; leaves erect, imbricated, very concave, ovate to obovate to spatulate, acuminate or obtuse at apex; margins usually involute, plane or somewhat recurved, usually toothed or lobed at or near apex, otherwise entire; costa excurrent as an elongated hyaline hair which is sometimes longer than the lamina but often much shorter; *costa bearing on the upper surface (usually 4) chlorophyllose lamellae*, widest near the apex and tapered to one cell high at the base of the leaf, usually toothed by projecting cells above and sometimes bearing protonema-like projections; median cells irregularly quadrate to transversely elongated, usually with fairly thick walls which are thicker on the underside of the leaf and somewhat collenchymatous, papillose or smooth on the back; basal cells larger, rectangular, quadrate to elongated longitudinally, smooth on both sides, thin-walled and often hyaline; apical cells quadrate or round to rhomboidal, often hyaline. Autoicous; antheridia in the axils of minute ecostate or weakly costate but not awned leaves, located either below the perichaetial leaves or on short branches near the base of the stem; paraphyses filamentous or clavate. Capsule immersed to long exserted, symmetrical, subglobose to oblong-cylindric; stomata superficial, in a row at the base of the capsule; exothecial cells irregularly rectangular, large; annulus lacking, indicated by 2–4 rows of round, thick-walled cells, or coming off as single cells; peristome lacking or present; operculum rostrate from a convex base. Calyptra smooth, mitrate or cucullate. Spores smooth to densely papillose, ripening in early spring. Type species, *P. subsessile*.

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KEY.

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|---|---------------------------|
| 1. Sporophyte immersed to emergent, calyptra mitrate. | 2. |
| Sporophyte emergent to exserted, calyptra cucullate. | 3. |
| 2. Spores densely papillose, leaves usually papillose on the back, apex not, or only slightly, lobed | 1. <i>subsessile</i> . |
| Spores smooth to slightly papillose, apex of leaf variously lobed. | 1a. var. <i>Henrici</i> . |
| 3. Peristomate, cells of lid obliquely twisted to left, leaves papillose on back, capsule long exserted. | 3. <i>lamellatum</i> . |
| Gymnostomous, cells of lid almost parallel to longitudinal axis, leaves smooth on back. | 2. <i>ovatum</i> . |

1. PTERIGONEURUM SUBSESSILE (Brid.) Jur. Laubmfl. Oesterr.-Ung. 96. 1882.

Gymnostomum subsessile Brid. Sp. Musc. 1: 35. 1806.

G. acaule Flörke in Web. & Mohr, Taschenb. 79 and 455. pl. 6, fig. 4-8. 1807.

Schistidium subsessile Flörke, Bryol. Germ. 1: 92. pl. 8, f. 1. 1823.

Pottia subsessilis Bryol. Eur. fasc. 18-20. pl. 117. 1843.

Fiedleria subsessilis Rabenh. D. Kryptfl. (Ed. 1) 2^o: 96. 1848.

Pharomitrium subsessile Schimp. Syn. (Ed. 1) 121. 1860.

Tortula subsessilis Mitt. Jour. Linn. Soc. 12: 164. 1869.

Plants forming compact, gray-green sods; stems simple or branched, up to 5 mm. high, usually 2-3 mm.; stem leaves erect, imbricated, obovate, obtuse to acuminate, up to 1.7 mm. long, very concave to cucullate; costa excurrent into an awn as long as or longer than the lamina; awn usually rough by projecting cells but occasionally smooth as in *P. ovatum*; 4 chlorophyllose lamellae on the upper side of costa, each approximately half as wide as one side of the lamina near apex and tapered to one cell high at base of leaf, seldom bearing protonema-like projections, standing at various angles to the lamina or lying parallel; median cells irregularly rounded, quadrate or transversely elongated, about 15 μ wide, usually thick-walled and collenchymatous, papillose on the back (the last three characters not evident in some specimens); basal cells larger, quadrate to longitudinally elongated, thinner-walled, and often hyaline; apical cells quadrate to round to rhomboidal, usually incrassate, sometimes a greater or less area hyaline; margins plane, entire except for toothed or slightly lobed apex; perichaetial leaves similar, often less convex, one or two, in some plants consisting largely of a rough awn. Autoicous; antheridia in the axils of minute, ecostate or weakly costate but not awned leaves, located at various places below the perichaetium or at the tips of so-called false branches, paraphyses filamentous, hyaline; capsules immersed to emergent, urn 0.4 to 0.7 mm. long, globose to subglobose, sometimes wider than long, irregularly wrinkled when dry, wide-mouthed, the mouth expanding when the lid falls, sometimes allowing the lid to fall into the cavity; gymnostomous; exothelial cells irregularly rectangular, longer than wide, thin-walled; annulus only indicated by 2-4 rows of smaller, rounded, incrassate cells; lid conic-rostrate, rostrum erect or oblique; calyptra mitrate, split into 3-5 lobes, occasionally appearing almost cucullate by splitting more on one side than the other; seta usually about 0.2 mm. long but occasionally equalling the length of the capsule; peristome lacking; spores 30-55 μ , papillose, with papillae thick enough to render the spores opaque in most specimens, maturing in early spring.

Type locality, Europe.

ILLUSTRATIONS:—Schwaegr. Suppl. 1: pl. 7; Bry. Eur. pl. 117; M. H. M. 160, f. 74.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1, 1856) 92, (Ed. 2) 118; Macoun Flora Can. 2323; Holz. Musc. Acro. Bor. Am. 230; Bartram, Mosses So. Ariz. 116.

On soil or rocks in exposed situations; Western North America, east to Illinois.

An extremely variable species, grading into the var. *Henrici*. Some specimens difficult to place, having some characteristics of the species and some of the variety. It is possible that the variety should be included in the species. A collection in the New York Botanical Garden made by E. Hall in Nebraska contains two extremes: one with the seta equal in length to the almost 0.8 mm.-long, globose capsule; the other having a normal sporophyte but most stem leaves having very low, papillose lamellae. The leaf apices on this specimen are also extremely variable, from lobed to entire and from obcordate to acuminate.

1a. Var. HENRICI (Rau) Wareham n. comb.

Barbula Henrici Rau, in Bull. Washburn Laboratory, Kansas 1: 172. 1886.

Crossidium Henrici (Rau) Broth., Paris, Ind. Bryol. (Ed. 2) 1: 356. 1904.

Pterigoneurum Henrici (Rau) E. G. Britton, Holzinger and Bartram in Bryol. 26: 68. 1923.

Differs from typical *P. subsessile* in being smaller in all parts except spores. Leaves averaging about 0.7 mm. long, narrower than *P. subsessile*; apex of many leaves lobed, hyaline; capsule subglobose, 0.5 mm. wide at mouth; spores smooth to extremely minutely papillose, comparatively thin-walled, 30–40 μ . Type locality, Saline Co., Kansas. Coll. Joseph Henry. *Pl. 99*.

EXSICCATI:—Type specimen collected by Joseph Henry, New York Bot. Gard.

In the original description by Rau the habitat is given as "on rocks." Judging by the appearance of the specimen, the rocks are sandstone. This moss was originally described as "dioecious" and "sterile." From notes by Mrs. Britton found with the specimen in the New York Botanical Garden, it is apparent that she examined the specimen carefully and sent parts of it to Holzinger and Bartram. All found antheridia, and Mrs. Britton found and sketched a lid. The author in re-examination of this material found several capsules containing spores, one of which still had the lid attached. These capsules were at least a year old and were covered by the accumulation of soil and sand. The author with hesitation retains this species as a variety. Considering the variability of *P. subsessilis*, it is entirely possible that it should be reduced to synonymy.

2. *PTERIGONEURUM OVATUM* (Hedw.) Dixon, Rev. Bryol. et Lichenol. 6: 96. 1933.

Bryum pusillum Hedw. Fund. Musc. 2: 32. 1782.

Gymnostomum pusillum Hedw. l. c. 87.

Pottia cavifolia Ehrh. Beitr. 1: 187. 1787; Bryol. Eur. fasc. 18–20. pl. 118. 1843.

Gymnostomum ovatum Hedw. Sp. Musc. 31. 1801.

Pottia pusilla Lindb. in Öfvers. Vet. Ak. Förh. 20: 410. 1863.

Tortula pusilla Mitt. Jour. Linn. Soc. 12: 165. 1869.

Aloina pusilla Kindb. Laubm. Schwed. u. Norw. 137. 1883.

Pterigoneurum cavifolium (Ehrh.) Jur. Laubmfl. 96. 1882.

Pterigoneurum pusillum (Hedw.) Broth. in Mönkemeyer, Krypt. Fl. 319. 1927.

Pterigoneurum cavifolium var. *β incanum* (Bryol. Germ.) Jur. Laubmfl. 96. 1882.

Plants forming broad, low sods, light green, bulbiform; stems simple or branched, up to 5 mm. high, usually about 3 mm.; upper leaves imbricated, very concave, ovate to obovate, usually acuminate, up to 1.4 mm. long; costa excurrent into an awn, usually much shorter but occasionally as long as or longer than the lamina; awn usually smooth but in some specimens roughened by projecting cells; lamellae 2, 4, or sometimes 6, each measuring half or less than half as wide as one side of the lamina at the apex and tapered to one cell high at the base of the leaf, usually bearing protonema-like projections, standing at various angles to the lamina or lying parallel; median cells rounded-quadrate to hexagonal, almost collenchymatously thickened, about 12 μ in diameter, not papillose on the back; basal cells elongated-rectangular, thinner-walled, sometimes hyaline; apical cells smaller than the median, usually rhomboidal, occasionally a few near the costa hyaline; margin entire, plane or sometimes slightly recurved; perichaetial leaves similar except that in many specimens the awn is shorter than in the lower leaves. Autoicous; antheridia in the axils of minute, usually ecostate leaves, located at various levels below the perichaetium; paraphyses usually somewhat clavate; capsules emergent to long exserted, ovate to oblong-cylindric, irregularly folded when empty; urn 0.7 to 1.5 mm. long, wide-mouthed, gymnostomous; exothecial cells irregularly rectangular, longer than wide, fairly thick-walled; annulus indicated only by 2–4 rows of smaller, rounded, incrassate cells; lid rostrate from a convex base, usually oblique, cells of rostrum parallel to longitudinal axis or very slightly inclined to the left; calyptra cucullate; seta 1.5 to 7 mm. long, usually 3–5 mm.; spores densely papillose, 18–34 μ ; maturing in early spring. Type locality, Europe.

ILLUSTRATIONS:—Braith. Brit. Moss. Fl. 1: pl. 30C; Bry. Eur. pl. 118; Dixon Handb. Brit. Mosses (Ed. 3) pl. 23L; Pl. 98.

EXSICCATI:—Macoun, Can. Musci, 17 & 18; U. S. Geol. Ex. 40th Par. 1379; Holz. Musc. Acro. Bor. Am. 231 and No. 85, which was dist. as var. *incanum*; Bartram Mosses of So. Ariz. 773; Grout, Musci Perf. 338. On alkaline or non-saline soil in exposed situations; western North America, east to North Dakota.

An extremely variable species. Forms having long awns and short setae were formerly designated as the var. *incanum*. The author, however, finds this combination of characters inconstant in both American and European material.

Bartram's Mosses of So. Ariz., 774, distributed as *P. cavifolium* var. *incanum* has a combination of characters not found in any other specimen examined or described. If rediscovered it may be worthy of description as a species. Leaves papillose at back; awn rough, long excurrent; lamellae papillose and protonematous; capsule scarcely exceeding the awns in height; gymnostomous; cells of lid slightly twisted to left; spores 30–45 μ , minutely but densely papillose.

3. PTERIGONEURUM LAMELLATUM (Lindb.) Jur. Laubmfl. 97. 1882.

Gymnostomum ovatum var. β *gracile* Hook. & Tayl. Musc. Brit. 12. 1818.

Pottia cavifolia var. δ *barbuloides* Durieu, Mscr. Schimp. Coroll. 24. 1856.

Tortula lamellata Lindb. de Tort. 233. 1864.

Barbula concava Schimp. Flora. 47: 210. 1864.

Barbula cavifolia Schimp. Syn. (Ed. 1) Add. 744 *ex parte*, 1860; Bry. Eur. Suppl. pl. 32. 1866.

Pottia barbuloides Durieu, in Husnot, Musc. Gall. 74. 1885.

Plants in gray-green sods, scarcely 1 cm. deep, usually about 5 mm.; stems simple; upper leaves concave, obovate to lingulate-spatulate, short acuminate, erect and loosely imbricated when wet, up to 1.9 mm. long, more or less crisped when dry; costa excurrent into a *smooth to slightly roughened awn* varying in length from very short to as long as or longer than the lamina; lamellae 4, chlorophyllose, *papillose, bearing protonemata* on the sides, irregular in shape, widest near the apex, tapered to 1 cell high at base of leaf, standing at various angles or lying parallel to the lamina; median cells rectangular to quadrate, about 13 μ wide, somewhat thickened and *papillose on the under side*; basal cells larger, rectangular, thinner-walled; apical cells roundish quadrate to rhomboidal, smaller than the median; margins sometimes serrate at apex, otherwise entire, *somewhat recurved* to near the apex; lower leaves smaller, ovate; perichaetial leaves not differentiated. Autoicous; antheridia in buds near the base of fruiting stems, surrounded by minute leaves, the innermost ecostate; paraphyses almost clavate with pointed end cells; capsules long-exserted, erect, oblong to cylindrical, symmetrical to slightly curved, irregularly folded when dry, the mouth not wide when ripe and empty, urn 0.8 to 1.7 mm. long; exothelial cells irregularly rectangular, longer than wide, comparatively thin-walled; annulus of one or two layers of cells coming off as separate cells, not a definite single layer as shown in the Bryologia Europea plate; lid obliquely rostrate, the cells strongly twisted to the left; peristome inserted at the mouth, yellowish and finely papillose, usually remaining in the falling lid; basal membrane low, teeth (32 and more) equally distant, of unequal height, straight or slightly twisted to the right, thread-like, nodose, bound together below irregularly by 2 and 3 cross articulations, above reduced to 16 teeth whose nodose fragments extend far into the rostrum; calyptra cucullate; seta 3–10 mm. long; spores 14–20 μ , extremely finely papillose, maturing in spring. Type locality, Europe.

ILLUSTRATIONS:—Bry. Eur. Suppl. pl. 32; Dixon, Handb. Brit. Mosses (Ed. 3) pl. 244; Braithw. Brit. Moss Fl. 1: pl. 30D; Pl. 98.

EXSICCATI:—Bartram, Flora of Pima Co., Ariz. Nos. 6, 18 & 23.

These specimens are located in the herbarium of E. B. Bartram at Bushkill, Pa.

On exposed soil, Arizona and Utah. The Utah specimen was collected by A. O. Garrett on an alkali flat west of Salt Lake City. It consists of one plant and is in the Bartram herbarium. The description of the peristome above was translated from Limpricht's Laubmoose, 1888. The only change is in the use of the terms "right" and "left" to conform to the usage as defined in the glossary, page 44 of Grout's M. H. M.

5. ALOINA (C. Muell.) Kindb. Bih. Sv. Vet.-Akad. Handl. 7³: 136. 1883.

Mrs. Ethelda J. Craig

Barbula Sect. *Aloideae* Fuernr. Flora 12: 598. 1829.

Barbula Sect. *Aloina* C. Muell. Syn. Musc. 1: 596. 1849.

Barbula Subg. *Tortula* Schimp. Coroll. Bryol. Eur. 31. 1856.

Tortula 1. *Aloidella* DeNot. Musc. Ital. 1: 14. 1862.

Aloidella Vent. in Comm. d. Fauna, Flora etc. Venezia No. 3. 1868.

Barbula Subg. *Aloidella* Schimp. Syn. (Ed. 2) 188. 1876.

Plants growing in tufts or clusters on the ground, small, bud-like, few-leaved, biennial, lime loving; stem very short, mostly simple, central strand wanting, tissue (in cross section) fairly uniform and thin-walled, its walls without pits or thin spots; rhizoids only at base, colorless; leaves stiff and thick, when dry mostly curved inward, when moist somewhat expanding, seldom adjacent or close, when old mostly reddish brown, tubular above the sheathing and hyaline base through the involute edges, or very concave; the margin plain, not bordered; the apex usually blunt, mostly cucullate, mostly without hair-point; costa very wide, about half as wide as blade, mostly not excurrent, in cross section 3–5 layers thick at the insertion, most strongly developed in *A. aloides*; somewhat higher up and adjacent to the dorsal cells are groups of stereids, which still farther up on the leaf limb fuse into a band which then occupies the space between the dorsal and the

ventral cells; guide cells not differentiated from the ventral cells, no accompanying or companion cells present; upper surface of the vein of the leaf limb covered with thread-like photosynthetic filaments; these filaments dichotomously branched, septate, green, their end cells pointed and thick-walled; lamina of one layer of cells; these cells weak in chlorophyll, smooth, those of leaf limb thick-walled especially the dorsal surface, quadrate, more or less wider than long, toward margin hyaline; cells of the leaf sheath hyaline, rectangular to elongate, thin-walled. Dioicous, seldom synoicous; male plants very small, intermingled with the female plants; perichaetial leaves somewhat larger, otherwise not differentiated; inflorescence terminal, bud-like, paraphyses longer than sex organs, filamentous to almost clavate; calyptra long-beaked, cucullate, smooth; seta elongate, twisted to right below and to left above; vaginula elongate and cylindrical; capsule mostly erect and regular, short-necked; stomata in the neck, in one row, with a roundish opening; cells of epidermis elongate, often many of them thick-walled; annulus differentiated, often persistent; lid beaked, mostly inclined; peristome teeth 32, spirally twisted to the left, papillose, not knotty or jointed, with low basal membrane; spores 10–27 μ . Type species, *A. aloides*.

All our species are alike in the abundance and length of the photosynthetic filaments on the upper surface of the leaf limb. The filaments are 2–5 cells high. Likewise all our species have a similar habitat.

KEY.

- A. Synoicous; leaves erect, close when dry or moist, peristome teeth twisted once. 1. *brevirostris*.
- AA. Dioicous; leaves curled-in when dry, spreading when moist.
 - B. Leaves 1.12–2.4 mm., broadly oblong; peristome teeth twisted 2–3 times.
 - C. Costa vanishing at blunt apex. 2. *rigida*.
 - CC. Costa extending into long hair. 2a. var. *pilifera*.
 - BB. Leaves 2.6–3.6 mm., linear-lanceolate; peristome teeth twisted once.
 - D. Calyptra reaching base of lid; capsule erect; basal membrane of peristome 5 cells high. 3a. var. *ambigua*.
 - DD. Calyptra reaching almost to middle of urn; capsule inclined; basal membrane of peristome 1–3 cells high. 3. *aloides*.

ALOINA BREVIROSTRIS (Hook. & Grev.) Kindb. Laubm. Schwed. u. Norw. 137. 1883.

Tortula brevirostris Hook. & Grev. Edinb. Jour. Sci. 1: 289. 1824.

Barbula rigida var. *brevirostris* Brid. Bryol. Univ. 1: 824. 1826.

Barbula brevirostris Bruch. Mueller in Flora 12: 406. 1829.

Tortula enervis Hartm. Skand. Fl. (Ed 2) 323. 1832.

Barbula macrorhyncha Kindb. in Macoun, Cat. Can. Pl. 7: 50. 1892.

Aloina macrorhyncha Broth. in Engler & Prantl. Nat. Pfl.-Fam. (Ed. 2) 10: 295. 1924.

Plants in small clusters, very small, bud-like when wet or dry, pale green or in age reddish brown; stem simple, very short, about 0.56 mm.; lower leaves very short, about 0.56 mm., ovate, obtuse; upper leaves 1–2.4 mm. long, 0.64–1.08 mm. broad, broadly oblong, obtuse and very concave; leaves erect; the margin involute above and rounded at tip, hyaline, not bordered; apex cucullate; costa 2/5–2/3 the width of the leaf at middle of limb, rather thin, not excurrent; photosynthetic filaments on limb very abundant, 3–5 cells long; median cells of leaf limb at 1/2 up about 19 μ long and 28 μ wide, vertically compressed so as to be transversely oblong or elliptical, thick-walled, brownish yellow, pellucid; median cells of leaf sheath up to 80 μ long and 28 μ wide, thin-walled, large, rectangular to rectangular-hexagonal, hyaline. Synoicous, some plants male and female and some only male; paraphyses thread-like; calyptra reaching almost to middle of urn; seta short, 12–18 mm. long, reddish-brown; capsule erect, straight, narrowly elliptical to cylindrical, leathery brown, slightly shiny, urn 1.6–2.4 mm. long by 500 μ broad, *outer cells about as q is to 1*, inner wall with ridges of single rows of cells; neck distinct; annulus of 3–4 rows of large cells, separating, breaking to pieces as it rolls up; *lid short, about 1/4–1/3 the length of urn*, conic to obliquely beaked, crenulate-margined; peristome teeth short, about 400–500 μ long, *making a single turn* to the left, nearer in pairs, purplish; basal membrane of peristome about 70 μ high, of 3–4 rows of cells, red; cell walls convex, projecting above the annulus; spores small about 14–18 μ , yellowish-green, *finely granular*, mature in early fall. Type locality, European.

ILLUSTRATIONS:—Limpr. Laubm. 1: 636. f. 179; Bry. Eur. pl. 138; Braithw. Brit. Moss Fl. 1: pl. 30E; Dixon, Handb. Brit. Mosses (Ed. 3) pl. 24B; Broth. Laubm. Fenn. f. 280-T; Pl. 99.

EXSICCATI:—Macoun, Can. Musci 2024, 72 in part, 185; Drumm. Musc. Am. 136; Williams, N. Am. Mosses 224; Husnot, Musci Galliae 708.

Examined:—F. A. McFadden, 8095 Mar. 23, 1931; Macoun, 334, Aug. 16, 1874, and North Hastings, Ont., Canada, 47–July 1891.

On earth and clay banks. Greenland; Rocky Mts.; Montana; British Columbia; Alaska; also Scotland, Denmark, Sweden, Siberia.

The only specimen seen of *Aloina macrorhyncha*, which was apparently of the type collection, proved to be somewhat smaller but otherwise not differing from *A. brevirostris*. In some specimens of *A. brevirostris* examined, the lid was found to be $\frac{1}{2}$ the length of the urn. In European specimens the leaves and capsules are shorter, and lid conic.

2. ALOINA RIGIDA (Hedw. ex p. Schultz) Kindb. l. c. 137. 1883.

Barbula rigida Hedw. Spec. Musc. 115. 1801.

Tortula enervis Hook. & Grev. Edinb. Jour. Sci. 1: 288. 1824.

Desmatodon rigidus Mitt. Musc. Ind. Orient. 1: 38. 1859.

Tortula stellata Lindb. de Tortul. 233. 1864.

Aloina stellata Kindb. Eur. and N. Am. Bryin. 270. 1897.

Plants in clusters, short, slightly larger than *A. brevirostris*, brownish; stem about 560 μ long, simple; leaves from an erect sheathing base, somewhat patent, when dry bent in at top, 1.4–2.3 mm. long, 500–900 μ wide; lower leaves small, ovate-oblong, ferruginous; upper leaves twice as long, oblong, deep green, usually longer and narrower, at the summit more spreading than in *A. brevirostris*; margin involute, not bordered; apex mostly cucullate; costa broad, $\frac{1}{2}$ the width of the leaf, vanishing at apex or rarely running out into a mucro or longer hair; upper surface of limb covered with photosynthetic filaments 2–5 cells high; median cells of leaf limb at $\frac{1}{2}$ up, 11–19 μ long and about 28 μ wide, walls thick; median cells of leaf sheath about 83 μ long and 28 μ broad, thin-walled, hyaline.

Dioicous; male plants minute; bracts three, broad, ovate; paraphyses thread-like; calyptra extending almost to middle of urn, straw-colored, long-beaked; seta 1–1 $\frac{1}{2}$ cm. long, reddish-brown; capsule erect, narrowly elliptical or ovate, shriveled when dry, larger than in *A. brevirostris* in European specimens; urn from 1.7–3 mm. long, about 500 μ wide, dirty brown, weakly shining, cells of epidermis about 3 : 1; annulus broad, of 2–3 rows of cells, separating, rolling up spirally; lid usually $\frac{1}{2}$ – $\frac{2}{3}$ the length of the urn, long-beaked, straight or slightly curved, persistent, margin crenulate; peristome teeth forming 2–3 turns of a spiral, about 0.68–1 mm. long, reddish, longer than in *A. brevirostris*; basal membrane of peristome 47–70 μ high, yellowish, projecting over the annulus; spores 10–17 μ , smooth, yellowish green. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. pl. 137; Braithw. Brit. Moss Fl. 1: pl. 30F; Dixon, Handb. Brit. Mosses (Ed. 3) pl. 24D; Pl. 99.

EXSICCATI:—Husnot, Musc. Gall. 258.

Examined: J. H. Savage 27; O. D. Allen, Calif. in 1928; F. M. Reed 45; Munz 4725, Calif.; Dr. J. Mueller 185; Macoun 16; E. H. Hall 125, and Bluffs of the Platte, lat. 40°, Field Museum No. 794819; Council Bluffs, Iowa (*Shimex*) Field Museum No. 92953.

On earth. Niagara, Illinois, Rocky Mts., California; Europe.

2a. Var. PILIFERA (Bry. Eur.) Limpr. Laubm. 1: 637. 1890.

Tortula bifrons DeNot. Sp. de Tortul. Ital. 17. 1837; Syll. Musc. Ital. 176. 1838.

Barbula rigida var. *pilifera* Bry. Eur. fasc. 13–15. 1842.

Tortula rigida var. *pilifera* DeNot. Musc. Ital. 1: 19. 1862.

Costa extending into a long hair about 84 μ long.

ILLUSTRATIONS:—Bry. Eur. pl. 137.

Examined: Verdugo Hills in Los Angeles County, California (McFadden 8116) 1931; Guadalupe Island (Edward Palmer 108) 1875.

On earth. California, Guadalupe Island; Europe.

No capsules were present on specimens examined.

This might be mistaken for a species of *Crossidium* but is distinguished by the much broader band of ventral and costal filaments and the incurved leaf margins.

3. *ALOINA ALOIDES* (Schultz) Kindb. Laubm. Schwed. u. Norw. 136. 1883.

Tortula rigida Sm. Fl. Brit. 3: 1249. 1805. Not of Hedw. 1801.

Trichostomum aloides Koch. Mscr.; Schultz in Nov. Acta. Acad. Caes. Leop. 11: 197. 1823.

Barbula aloides Fuernr. Flora 12: 598. 1829; Bry. Eur. fasc. 13-15: 15. 1842.

Tortula aloides DeNot. Syll. Musc. Ital. 177. 1838.

Tortula aloides Aongstr. Nov. Acta Soc. Upsala 12: 377. 1844.

Plants in dense patches, somewhat more vigorous than *A. rigida*, dull green to reddish-brown; stem about 920 μ long; leaves only a little standing off or patent, when dry bent or curled in, larger than in *A. rigida*, linear-lanceolate, reddish-brown; the lower ones about 800 μ long, the upper ones 2.6-3.6 mm. long and about 600 μ broad; margin involute; apex incurved and cucullate, rarely pointed; costa $\frac{1}{3}$ - $\frac{1}{2}$ the width of the leaf, sometimes thickened in the middle, convex at back, covered above by photosynthetic filaments 2-5 cells high; median cells of leaf limb at $\frac{1}{2}$ up about 11 μ long and 28 μ wide, thick-walled and vertically compressed; median cells of sheath about 56 μ long, and 22 μ wide, thin-walled and hyaline.

Dioicous; paraphyses thread-like to almost clavate; *calyptra* reaching from a little below the lid almost to middle of the urn; seta 1-1.5 cm. long, yellowish above to reddish-brown below; capsule slightly inclined, straight to a little curved, cylindric, reddish-brown and shining, of rather thick texture, in age irregularly, longitudinally wrinkled; urn about 2.5-3 mm. long and 800 μ wide, with epidermal cells as 3 is to 1; annulus narrow, of 1-2 rows of small cells, persistent; lid $\frac{1}{3}$ - $\frac{1}{2}$ the length of the urn, easily deciduous, beak thick and blunt to somewhat slender, its margin crenulate; peristome teeth short, about 680 μ long, twisted once, curved in when dry, with tips pointing upwards, yellowish-red; *basal membrane* of peristome 1-3 rows of cells, *not projecting* above the *annulus*, light yellow; spores 15-27 μ in diameter, greenish-yellow, smooth. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. *pl.* 139; Engler and Prantl, Nat. Pfl.-Fam. (Ed. 2) 10: *f.* 240; Dixon, Handb. Brit. Mosses (Ed. 3) *pl.* 24E; *Pl.* 99.

EXSICCATI:—Rabenhorst, Bryoth. Eur. 786; Ren. and Card. Musci Eur. Exsic. 121; Husnot, Musc. Gall. 10.

Examined: Rheinland, Germany (A. Schumacher Dec. 1929); Hessen, Darmstadt, Germany (Roth Nov. 1885); Dier Khouna, Syria (W. B. Evans, Feb. 14, 1931); Swanage, England (Mitten 1906).

On earth and clay walls. Newfoundland (Paris); also British Isles, Europe, Asia Minor, Algeria.

3a. Var. *AMBIGUA* (Bry. Eur.) n. comb.

Barbula rigida Hedw. Stirp. Crypt. 1: 65. 1785; Brid. Bryol. Univ. 1: 528 et 824 excl. syn. Schultz 1826. Not of Hedw. 1801.

Tortula rigida Brid. Spec. Musc. Suppl. 1: 245. 1806. Not *Barbula rigida* Hedw. 1801.

Barbula ambigua Bry. Eur. fasc. 13-15: 14. 1842.

Tortula ambigua Aongstr. Nov. Acta Soc. Upsala. 12: 376. 1844.

Tortula ericaefolia Lindb. Musc. Scand. 20. 1879.

Aloina ericaefolia Kindb. l. c. 137. 1883.

Aloina ambigua (Bry. Eur.) Limpr. Laubm. 1: 638. 1890.

Leaf apex sometimes acute; calyptra scarcely reaching the base of the lid and falling off with it; *basal membrane* of peristome about 70 μ high, composed of about 5 rows of light yellow cells, *projecting above* the *annulus*. Type locality, Scotland.

On earth and clay walls. Illinois (*E. Hall*), British Columbia (Macoun), California; also in central, west and south Europe, Norway, England, Algier, Tunis, Caucasus, Western Asia.

ILLUSTRATIONS:—Bry. Eur. *pl.* 139; Limpr. Laubm. 1: *f.* 180; Braithw. Brit. Moss Flora 1: *pl.* 30G; M. H. M. 161. *f.* 75.

EXSICCATI:—F. Renaud & J. Cardot, Musci Eur. Exsic. 120; W. Migula, Kryptog. Germ. Austr. 151.

Examined: France (Herbier Charrier, Apr. 17, 1932); Rheinland, Germany (Schumacher, 15/10/26) as *A. rigida*; Athens, Illinois (*E. Hall* 1862).*

No specimens of *Aloina aloides* proper from North America were seen. European specimens of both this and *A. ambigua* were examined, however. In these examinations the distinguishing characters did not hold,

*Hall's specimen has leaves 2.8-3.2 mm. long and about 0.68 mm. wide. Dioicous; calyptra lacking; capsule erect, straight, cylindric; urn 3.2 x 0.8 mm.; annulus narrow, persistent; operculum lacking; peristome teeth short, twisted once; basal membrane of about 5 rows of cells projecting above the annulus.

for the most part. The leaves were found to be the same in length; the apex blunt in both species, except in one specimen as *A. ambigua* with part of the leaves with apex acute and part with apex blunt on the same plant; costa of *A. aloides* not always thickened; the *calyptra* was not seen in either species; capsule slightly inclined to the horizontal in *A. aloides*, and usually erect in *A. ambigua*; urn the same in length; lid somewhat thick and blunt to slender-beaked, $\frac{1}{4}$ – $\frac{1}{2}$ the length of the urn; peristome teeth found to be the same in length; basal membrane of peristome of 1–3 rows of small cells, not projecting above the annulus in *A. aloides*, while in *A. ambigua* the basal membrane is $70\ \mu$ high, composed of 5 rows of cells projecting above the annulus; no difference was found in the size of the spores.

It is my opinion that the differences in the height of the basal membrane of the peristome, the slight inclination of the capsule, and the possible difference in the length of the calyptra are not great enough to make separate species, but that *A. ambigua* becomes a variety of *A. aloides*.

6. CROSSIDIUM Jur. Laubmfl. 127. 1882.

Barbula, section *Chloronotae* Bry. Eur. fasc. 12–15. 1842.

Plants xerophytic, calcicolous, small, in dense hoary tufts; stems sparingly branched; central strand well developed; lower leaves smaller, the upper close and much larger with longer hyaline awns; strongly concave, appressed, oblong-ovate to oblong, acuminate to emarginate; margins recurved to narrowly revolute in part; costa strong, larger above and covered with a dense growth of green cellular threads, which apparently are useful in absorbing water and in assimilation, doubtfully in reproduction, in cross section showing a ventral mass of large cells giving rise to the filaments, a dorsal group of small (stereid) cells and between these a group of small thin-walled cells; leaf cells smooth, thick walled, and oval to short-oblong or hexagonal above with little chlorophyll; the lower thin-walled, hyaline, rectangular to narrowly hexagonal, more or less collenchymatous; perichaetial leaves little different except in *C. spatulaefolium*, the inner often smaller. Dioicous or monoicous; seta long-exserted, erect; capsule oblong-elliptic to oblong-cylindric, erect and symmetric or nearly so; calyptra cucullate, large, smooth; operculum, thimble-shaped to conic with cells oblique or spirally arranged; peristome as in *Barbula* or less developed and more irregular from a low basal membrane. Type species, *C. squamigerum*.

Bartram and Holzinger (Bryol. 26: 68. 1923) reached the following conclusions after a careful study of the genus: *C. chloronotos* (Brid. in part) Limpr. is not found in North America. *C. Henrici* (*Rau) Kindb. is a *Pterygoneurum*.

A great deal of confusion has been caused by the fact that Bridel included both *C. squamigerum* and *C. chloronotos* under his *Barbula chloronotos*. Also the leaves of *C. squamigerum* and *C. griseum* are so much alike that they have often been confused.

Husnot, Musc. Gall. 66B as *Barbula membranifolia* Hook. is *C. griseum*. Rabenhorst's Bryotheca Eur. 672 as *Barbula chloronotos* is *C. squamigerum* and his 1272 as *Barbula chloronotos* is a *Tortula*, at least in two collections studied.

KEY.

- | | |
|---|----------------------------|
| 1. Leaf border near apex colorless with cells elongate. | 2. |
| Leaf cells of border near apex not elongated or colorless. | 3. |
| 2. Costal filaments thick-walled throughout; elongate cells of beak of operculum arranged in a spiral of more than one turn; peristome teeth long and slender twisted more than one turn. | 1. <i>squamigerum</i> . |
| Only the upper 1 or 2 cells of costal filaments thick-walled; cells of operculum merely oblique; peristome shorter, only slightly twisted, the teeth more or less connate. | 2. <i>griseum</i> . |
| 3. Leaf cells strongly papillose. | 5. |
| Leaf cells smooth, rarely with faint papillae near the apex of some leaves. | 4. |
| 4. Leaves entire at apex; hyaline hair point often longer than the blade. | 3. <i>desertorum</i> . |
| Leaves erose dentate at the blunt or emarginate apex, hair point usually shorter than the blade. | 4. <i>erosum</i> . |
| 5. Perichaetial leaves not or scarcely spatulate. | 5. <i>aberrans</i> . |
| Perichaetial leaves strongly spatulate. | 6. <i>spatulaefolium</i> . |

* Not Ren.

1. *CROSSIDIUM SQUAMIGERUM* (Viv.) Jur. l. c.

Barbula squamigera Viv. Ann. Bot. 1²: 191. 1804.

Tortula chloronotos Brid. Sp. Musc. 1: 253. 1806. Not of later authors.

Tortula membranifolia Hook. Musc. Exot. 1: pl. 26. 1818.

Desmatodon chloronotos Mitt. Musc. Ind. Orient. 38. 1859.

Plants in dense tufts, gray-green, up to 2 mm. high; leaves erect-spreading, appressed when dry, concave, ± 1 mm. long, ovate-oblong, acuminate, colorless on the margins near the apex; margins plane or slightly reflexed, serrate near apex; costa rough at back near the apex, extending into a hyaline, somewhat rough hair point equaling or exceeding the length of the blade; costal filaments with 3-4 of the end cells thick-walled, the terminal cells elongate-conic with two or more large papillae; basal leaf cells short-rectangular, smaller near the margin, the median rounded-oval, thick-walled with lumen about 15μ in longest dimension; marginal cells near apex colorless, elongate-oblong to linear. Monoicous; antheridial buds at base of perichaetium or in a short offshoot; seta 1-2.4 mm. long, yellowish, turning darker with age; capsule erect and symmetric or nearly so, urn oblong-cylindric, slightly broader below, up to 3 mm. long; operculum conic-rostrate, $\frac{1}{3}$ - $\frac{1}{2}$ the length of the urn, cells of beak elongate and spirally arranged for about two turns; annulus of small cells; peristome teeth from a basal membrane up to 90μ high, bifid into long filiform prongs, papillose and about twice twisted; spores 14 - 20μ , mature in early spring. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. pl. 140; Pl. 100.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 95b, (Ed. 2) 126.

Apparently calcicolous; California and Arizona (*Bigelow*); Rocky Mountains (*Hall*).

2. *CROSSIDIUM GRISEUM* (Jur.) Jur. Laubmfl. 128. 1882.

Desmatodon griseus Jur. in Verh. d. Zool-bot. Ges. Wien 1864: 399. 1864.

Barbula membranifolia var. *grisea* Vent. in Comment d. Fauna, Flora etc. Venezia no. 3. 1868.

Barbula grisea Boulay, Musc. d. l. France 1: 434. 1884.

Crossidium succulentum Holz. & Bartr. Bryol. 26: 69. 1923.

Closely cespitose in dense gray-green cushions, 4-6 mm. high, tender and succulent in texture when moist, hardly so when moistened after drying; leaves erect-spreading, loosely imbricate, blade up to 2 mm. long, oblong-ovate, usually bluntly rounded and subcucullate at apex; margins plane or slightly recurved, entire below, sharply serrate at the colorless apex; nearly or quite as long as the blade; leaf cells smooth, short-rectangular at base, becoming smaller above, irregularly oblong and transversely elongated above, in the hyaline margin at apex becoming very thick-walled, often with linear lumen 15 - 25μ long; costa strong, excurrent into a hyaline, faintly toothed hair wider above often with sharp papillae at back near apex and covered with a dense opaque mass of 3-5 celled filaments occupying more than $\frac{2}{3}$ of the upper surface of the leaf in the concave spoon-shaped hollow of the leaf, with apical cell elongate, conic, thick-walled and crowned with 1-3 large horn-like papillae, the other filament cells are short-ovoid and thin-walled, chlorophyllose. Autoicous; perichaetial leaves little differentiated, the inner apparently narrower with a larger area of thin-walled rectangular basal cells; antheridia below the base of the perichaetium, surrounded by one or two small leaves little longer than the antheridia and club-shaped paraphyses; seta ± 1 cm. in length, orange; capsule erect and symmetric, oblong-cylindric, urn ± 2 mm. long; operculum conic-rostrate, not over $\frac{1}{2}$ the length of the urn, the elongate cells of the beak oblique but scarcely spirally arranged; annulus inconspicuous; peristome teeth from a narrow basal membrane, up to 0.24 mm. long, red-brown, irregularly divided and connate, strongly papillose with narrow high papillae; spores 10 - 12μ , mature in early spring. Type locality, Austria.

ILLUSTRATIONS:—Bryol. 26. pl. 5; Limpr. Laubm. 1: f. 181; Pl. 99.

EXSICCATI:—Bartr. Mosses S. Arizona, 65; Holz. Musc. Acro. Bor. Am. 484, 631; Husnot, Musc. Gall. 66B, as *Barbula membranifolia*.

The more obtuse leaves and smooth costa by which Bartram and Limpricht would distinguish this from the preceding do not seem to hold, but the differences cited in the key are pretty definite. The available European material has been scanty but a careful comparison of the available material of *C. succulentum* and *C. griseum* fail to show any differences beyond the range of normal variation. Mr. Bartram agrees with this decision.

On dry shaded banks and rock clefts; Arizona (*Bartram*), California (*Coville & Funston*; *Bigelow*).

3. *CROSSIDIUM DESERTORUM* Holz. & Bartr. Bryol. 26: 72. pl. 6. 1923.

Plants closely caespitose in thin wide olive-green mats, up to 3 mm. high; leaves erect and closely imbricate when dry, spreading when moist, usually 0.75–1 mm. long, concave, oblong-ligulate, obtuse; margins entire, narrowly revolute to below the middle, terminated by an almost smooth hyaline hair 1 mm. or more in length and usually much exceeding the leaf in length; costa weak below, becoming wider and stronger above and bearing in the upper $\frac{1}{2}$ a dense mass of filaments covering more than $\frac{1}{2}$ the upper surface of the lamina, with apical cells conical and terminating in 1–2 weak papillae; leaf cells smooth, hyaline and short rectangular at base, becoming rounded-quadrate to transversely oval in the leaf middle and irregularly rhombic oval, 8–10 μ in diameter. Dioicous; antheridial buds terminal on plants more slender than the archegonial; sporophytes much like those of *C. chloronotos* (Brid.) Limpr. except that the peristome is much shorter and less twisted from a rather broader basal membrane. Also the perichaetial leaves are more rounded-obtuse. Type locality, high shaded banks along dry washes near Tucson, Pima Co., Arizona (Bartram no. 547, Feb. 5, 1923).

ILLUSTRATIONS:—Bryol. l. c.; Pl. 101.

EXSICCATI:—Holz. Musc. Acro. Bor. Am. 483; Bartr. Mosses S. Arizona 67.

Nearest the European *C. chloronotos*, from which it differs in the narrower ligulate outline of the leaves, the broader filamentose area covering much more of the leaf surface and the basal cells shortly rectangular and hyaline instead of enlarged and yellowish. Description adapted with few changes from the original description. Mr. Bartram has collected this species in several other neighboring localities in Arizona.

Much of the material of *C. desertorum* available is depauperate and poorly developed, which accounts for the difference in the basal cells, which is not constant. I have seen European *C. chloronotos* with the costal filaments covering fully $\frac{1}{2}$ the width of the upper leaf. The leaf margins of *chloronotos* are much more recurved than is shown in Bry. Eur. pl. 141. The European exsiccati are badly mixed but Bauer, Musc. Eur. et Amer. Exsicc. 2112a and Husnot, Musc. Gall. 453, are true *chloronotos*.

4. *CROSSIDIUM EROSUM* Holz. & Bartr. Bryol. 27: 3. 1924.

"Dioicous. Caespitose in pale green mats, older parts brown, about 2 mm. high, radiculose at base. Leaves erect and incurved or very slightly contorted when dry, spreading when moist, about 1.5 mm. long, concave, ovate, obtuse or emarginate, margins entire and reflexed in the middle portion, plane and erose-dentate at apex, terminated by an almost smooth hyaline hair which is normally shorter than the leaf or even reduced to a colored mucro in the emarginate forms. Leaf cells hyaline and short rectangular at base, round-quadrate above, 10–12 μ in diameter, mostly smooth on both sides. Costa about 60 μ wide at the base, covered in the upper half with 3- to 5-celled chlorophyllose filaments, the terminal cell of which is conical with one or two weak apical papillae. Male plants not seen. Pedicel reddish yellow, flexuous, lightly twisted to the left when dry, about 10–15 mm. long. Capsule cylindric, brown, 1.5 mm. long x 4 mm. wide. Operculum conic, blunt, slightly curved, 7 mm. long with the cells arranged in spiral lines. Calyptra cucullate, covering about one-third of the capsule. Annulus narrow, of two or three rows of small pellucid cells. Peristome teeth 32, linear, pale yellow, about 0.4 mm. long, papillose, twisted in one spiral turn from a basal membrane extending 50–65 μ above the mouth of the capsule. Spores ovoid, smooth, 8–10 μ in diameter.

"Type: Mesa north of Rillito Creek, Pima County, Arizona. E. B. Bartram, No. 11, January 16, 1920."

ILLUSTRATIONS:—Bryol. l. c. pl. 1; Pl. 101.

EXSICCATI:—Holz. Musc. Acro. Bor. Am. 504, 629; Bartram, Mosses S. Arizona 120, 121. Both have some papillose leaves.

"Distinguished from *C. desertorum* by the shorter hair-points and narrower filamentose area and from *C. chloronotos*, to which it is evidently closely allied, by the rounded erose-dentate apical leaf margins, and also by the shorter basal cells of the leaves.

"It is to be noted that the inner perichaetial leaves of the species are narrowly lanceolate, with a short hair-point or none, and the costa in some, ceases a distance below the apex, or is absent. Also, the costal filaments on them are few or disappear entirely."

Quotations from the original descriptions.

The operculum may be 1 mm. or more in length. The length of the basal leaf cells varies from 30–60 μ in both *C. chloronotos* and *C. erosum* and it is difficult to see any constant difference between the species in this respect. In both species a few papillae may be seen on the upper part of some leaves.

5. *CROSSIDIUM ABERRANS* Holz. & Bartr. Bryol. 27: 4. pl. 2. 1924.

"Autoicous?¹ Caespitose in interwoven green mats, older plants light brown, radiculose at base; plants often growing from the leaf axils of old stems, and apparently reproduced from axillary gonidial threads; leaves erect and spirally contorted when dry, spreading when moist, to 1.4 mm. long; hair-point smooth, up to 1 mm. long; perichaetial leaves oval, usually widest at base, the inner usually retuse at apex and without hair point, the 2-3 others short-apiculate by the more or less excurrent costa"; all rounded at apex; margin entire and broadly reflexed; leaf cells at base hyaline, thin-walled, short-rectangular, about 2 : 1, in the median portion quadrate-hexagonal to transversely rectangular, towards the apex round-hexagonal, 10-15 μ in diameter, somewhat mamilllose on the dorsal face; costa about 60 μ wide at base, bearing on the ventral surface in the upper $\frac{1}{2}$ scattered clusters of short filaments barely exceeding the width of the costa in length and often consisting of only a single cell bearing several knob-like small papillae. Seta \pm 12 mm. long, erect; capsule oblong-cylindric, about 2 mm. long; operculum 0.8-1 mm. long with spirally arranged cells; peristome about 0.8 mm. long, of 32 slender papillose filaments from a basal membrane about 60 μ wide, twisted about one turn to the left; spores about 10 μ in diameter, mature in winter. Type locality, shaded ground among boulders in Soldier's Canyon, Santa Catalina Mts., Pima Co., Arizona, Jan. 27. 1923 (Bartram, no. 484).

ILLUSTRATIONS:—Bryol. l. c. & p. 6, f. 1; Pl. 102.

EXSICCATI:—Bartr. Mosses S. Arizona 66, 122.

Also from California (Bigelow) in the James herbarium as *C. chloronotos*.

Under the microscope the comparatively small area covered by the costal filaments is strikingly different from the preceding species. One must look carefully to see the mamillae in profile as they are quite inconspicuous. The description is adapted from the original.

6. *CROSSIDIUM SPATULAEFOLIUM* Holz. & Bartr. Bryol. 27: 6. pl. 3. 1923.

Plants with the general appearance of *C. aberrans*, but apparently more robust, up to 3 mm. high. Leaves up to 1.5 mm. long, 0.2-0.3 mm. wide; perichaetial leaves up to 1.9 mm. long, rounded or shortly mucronate at apex, with the costa in some cases ending below the apex, the inner spatulate from a narrow elongate base of pellucid rectangular cells, 16-25 μ wide and 1-9 : 1; leaf cells of upper leaf in general more sharply papillose and mamilllose than in *C. aberrans* and the costa often papillose at back near the apex; peristome also longer and more twisted. Type locality "On rocks near Nogales, Arizona" (Leiberg, no. 1030, Feb. 1906), in the herbarium of the New York Botanical Garden as *C. chloronotos*.

ILLUSTRATIONS:—Bryol. l. c.; Pl. 102.

EXSICCATI:—Holz. Musc. Acro. Bor. Am. 630.

Evidently not as distinct as the authors thought for there are spatulate leaves in Bartram's Mosses of Southern Arizona no. 122. Perhaps better considered as a variety of *C. aberrans*.

7. *HUSNOTIELLA* Card. Rev. Bryol. 36: 71. 1909.

Plants small, caespitose; stems short, erect; leaves ovate to shortly lingulate, rounded at apex; margins entire, strongly revolute; costa strong, vanishing below the apex, often upwardly thickened, in cross section with ventral guides and a dorsal stereid band only; upper leaf cells quadrate or rounded-hexagonal, more or less papillose to nearly smooth; seta erect, rather long; capsules subcylindric; operculum conic-rostrate; annulus present; peristome very rudimentary or lacking; calyptra cucullate. Type species, *H. revoluta*. (Description translated from the original.)

¹1 Note.—The inflorescence in this and the following species is apparently dioicous. The dissection of a number of plants failed to reveal antheridia on archegonial rosettes. And, in only three of such rosettes were antheridial buds discovered. These grew from one of the inner perichaetial leaves at the base of the seta. They consisted of two perigonial bracts, one with short costa, the other ecostate and rounded at apex. Two of these contained only paraphyses, which were club-shaped, as they are in this genus. The third bud contained in addition two young antheridia. We surmise that the scarcity of antheridial buds is due to the very early collection of these plants, in January. Under the circumstances we can not with certainty ascribe dioicous inflorescence to them."

KEY

1. Leaves oblong-lanceolate to ovate-lanceolate; costa not or indistinctly spurred 3.
 Leaves broadly ovate to lingulate; costa laterally spurred above 2.
2. Leaves broadly ovate-lingulate, rounded at apex, erect-imbricate when dry 1. *revoluta*.
 Leaves lingulate, more apiculate, crisped when dry 1a. var. *Palmeri*.
3. Leaves ovate-oblong; perichaetial leaves lingulate, broadly obtuse; costa ending well
 below the apex 3. *Pringlei*.
 Leaves linear-lanceolate to oblong-lanceolate; perichaetial leaves little different 2. *torquescens*.

1. HUSNOTIELLA REVOLUTA Card. l. c.

Didymodon revolutus Williams, Bryol. 16: 25. 1913.

Plants densely cespitose; stems short, up to 6 mm., erect; leaves contorted-appressed when dry, widely spreading to almost reflexed when moist, ovate to ovate-lingulate, obtuse and rounded at apex; margins entire, strongly revolute except at base; costa strong, irregularly wider and spurred above and often sublamellose ventrally, ending abruptly below the apex, in cross section with large ventral cells and a single dorsal stereid band; upper leaf cells small, 7-10 μ , obscure, rounded, more or less papillose or mamilllose; lower cells larger, nearly hyaline, smooth, quadrate to short-rectangular; perichaetial leaves subsheathing at base, longer and more loosely areolate, otherwise little different. Apparently dioicous as no antheridial buds were found; seta reddish, 6-8 mm. long; capsule erect, subcylindric; operculum conic-rostrate, $\frac{1}{3}$ - $\frac{1}{2}$ the length of the urn; annulus present, dehiscent in fragments; peristome lacking or consisting of a short delicate, irregular membrane; calyptra cucullate, covering $\frac{1}{2}$ of the capsule. Type locality, Mexico. Pl. 119.

EXSICCATI:—Bartram, Mosses S. Arizona 127, as *H. torquescens*.

The plants appear to grow in dense thin mats with the lower portion of the stems imbedded in lime accretions from the soil or rocks.

On masonry walls and alkaline soil Fort Davis and Brownsville, Texas (*Orcutt*); Arizona (*Bartram*, nos. 119, 1189, 1650); near Kenwood, Calif. (*Koch and Baker* 5-5-1938). Frequent in the elevated districts of northern and central Mexico.

1a. Var. PALMERI (Card.)* Thér. Smithosian Misc. 854: 7. 1931.

Husnotiella Palmeri Card. Rev. Bryol. 37: 121. 1910.

Leaves narrower, linear-lingulate, sometimes acute or apiculate. Type locality, Durango, Mexico (*Palmer*, 761). Probably only an occasional variation, as the type was found with the variety in Oklahoma (*Little*) and elsewhere.

2. HUSNOTIELLA TORQUESCENS (Card.) Bartr. Bryol. 29: 45. 1926.

Didymodon torquescens Card. Rev. Bryol. 36: 83. 1909.

Plants cespitose, bright green above, paler below, 2-10 mm. high; leaves somewhat clustered at the top of the stem, erect-spreading when moist, spirally contorted when dry, narrowly oblong-lanceolate, \pm 1 mm. long, obtuse, acute, or apiculate; margins entire, strongly revolute except at base; costa strong, percurrent or nearly so, in cross section same as *H. revoluta*; upper leaf cells rounded, unistratose, papillose with broad low papillae; basal quadrate, smooth. Dioicous; seta 4-7 mm. long; capsule erect, oblong-subcylindric, operculum conic-rostrate; annulus distinct, narrow, deciduous; peristome rudimentary, teeth very short, fugacious. Type locality, State of Michoacan, Mexico. Also two localities in Arizona (*Bartram*); Texas, (*Orcutt*, 7090). Pl. 119.

Both this and the preceding appear like a thin green crust over the substratum.

3. HUSNOTIELLA PRINGLEI (E. G. Britton) n. comb.

Dactylhymenium Pringlei (E. G. Britton, Ms.) Card. Rev. Bryol. 36: 72. 1909.

Gyroweisia Pringlei E. G. Britton, Ms., according to Cardot, l. c.

* See. Bryol. 16: 25; 29: 44; 32: 7.

Plants densely caespitose, 2–3 mm. high; stems slender, erect, loosely foliate; leaves erect-incurved when dry, widely spreading when moist; ovate-lanceolate, broadly and obtusely acuminate, up to 1 mm. long; margins entire, strongly revolute except at extreme base and apex; costa papillose at back, ending well below apex in most leaves, in cross section in some portions with nearly uniform cells, in others with large ventral cells and a single dorsal stereid band; upper leaf cells small, 7–10 μ , rounded-quadrate to irregular, smaller near the margin, strongly papillose, cells near the base larger, short-rectangular, less papillose; perichaetial leaves oblong-lingulate. Antheridia not found; sporophytes often lateral; seta straight, erect, \pm 1 mm. long; capsule oblong to subcylindric, urn 1 mm. or more in length, erect and symmetric; operculum conic-rostrate, more than $\frac{1}{2}$ the length of the urn; peristome of a narrow membrane, granular and somewhat perforate; annulus narrow, of small cells, persistent. Type locality, State of Chihuahua, Mexico. *Pl.* 119.

EXSICCATI:—Bartram, Mosses S. Arizona, 73, 112; Holz. Musc. Acro. Bor. Am. 632. Also in New Mexico (*Rusby*); Santa Catalina Island (*Kingman*).

8. DESMATODON Brid. Musc. Recent. Suppl. 4: 86. 1819.

Plaubelia Brid. Bryol. Univ. 1: 522. 1826.

Mostly plants of high altitudes or latitudes, small or medium sized, usually growing in rather compact cushions on soil; stems usually with central strand, simple or somewhat branching; leaves usually close, erect-appressed and somewhat incurved or contorted when dry, ovate, oblong, oblong-lanceolate or rarely somewhat spatulate, broadly acute to obtuse, entire or slightly serrulate near the apex; margins plane, recurved or broadly incurved; costa strong, vanishing below the apex to slightly excurrent, more rarely extending into a short nearly smooth hair-point, in cross section showing 2–4 median guides with one or two rows of somewhat smaller large cells ventrally, a dorsal stereid band with dorsal layer of cells differentiated; upper leaf cells small, quadrate to hexagonal or irregular, rarely elongated, mostly distinct but thick-walled and mamillate to papillose, less frequently densely papillose and obscure; lower leaf cells smooth, pale, larger and elongate; perichaetial leaves little different as a rule. Monoicous or dioicous; seta elongate, usually twisted; capsule oblong to cylindric, usually erect and symmetric but in some cases unsymmetric, curved and cernuous (*D. cernuus*); annulus usually present, often persistent and inconspicuous; stomata few, mostly near the capsule base; peristome papillose, jointed, the 16 teeth (often poorly developed in *D. obtusifolius*) from a narrow basal membrane, mostly divided to near the base into 2–3 slender prongs, often irregular and irregularly anastomosing; calyptra large, cucullate. Type species, *D. latifolius*.

Acknowledgments are freely made to Williams' monograph, Bull. Torr. Club 46: 207–220. 1919. There *D. systilioides* R. & C. from Newfoundland is assigned to *Pottia*.

The peristomes are much like those of *Didymodon* but not the structure of the costa which is distinctly Pottioid.

KEY.

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|--|-------------------------|
| 1. Leaves distinctly bordered to near apex by a thickened band of narrow cells; capsules cernuous or pendent..... | 2. |
| Leaves bordered by a band of lighter cells little different or slightly more elongate | 11. |
| Leaves not bordered; capsules erect and symmetric or nearly so..... | 3. |
| 2. Leaves strongly papillose; capsules strongly inclined to pendulous; cells of operculum oblique; peristome teeth twisted one turn..... | 13. <i>Laureri</i> . |
| Leaves smooth to lightly papillose; capsules curved and cernuous; cells of operculum not oblique; peristome teeth not twisted..... | 12. <i>cernuus</i> . |
| 3. Cells of upper portion of leaf papillose with variously shaped papillae..... | 4. |
| Cells of upper leaf not papillose but often more or less mamillate..... | 12. |
| 4. Upper leaves at least hair-pointed or awned by the excurrent costa..... | 5. |
| Upper leaves not awned or hair-pointed; costa sometimes barely excurrent..... | 8. |
| 5. Blade of upper leaves 1.5 mm. long or even less..... | 3. <i>Guepini</i> . |
| Blade of upper leaves 2–3 mm. long..... | 6. |
| 6. Monoicous; upper leaf cells up to 12–18 μ ; Rocky Mts. and subarctic..... | 7. |
| Dioicous; upper leaf cells up to 10 μ ; range from Pennsylvania to Alabama and Texas. | 5. <i>plinthobius</i> . |
| 7. Leaves spatulate to oblong..... | 1. <i>latifolius</i> . |
| Leaves gradually tapering from below the middle to an acute apex..... | 2. <i>suberectus</i> . |

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|--|---------------------------|
| 8. Leaves ovate-lanceolate to oblong-lanceolate; operculum long-rostrate, $\frac{2}{3}$ the length of urn..... | 10. |
| Leaves oblong-lingulate to oblong or oblong-ovate; operculum short-rostrate..... | 9. |
| 9. Upper leaf cells up to 8 μ | 7. <i>obtusifolius</i> . |
| Upper leaf cells about 18 μ | 1a. var. <i>muticus</i> . |
| 10. Leaves rounded-obtuse to apiculate; costa scarcely percurrent..... | 8. <i>Hendersoni</i> . |
| Leaves acute; costa percurrent to excurrent..... | 9. <i>convolutus</i> . |
| 11. Leaves obtuse, rounded or abruptly apiculate..... | 10. <i>coloradensis</i> . |
| Leaves acute..... | 6. <i>Porteri</i> . |
| 12. Leaf margins strongly involute; costa ending in the apex or below it..... | 11. <i>Sprengelii</i> . |
| Leaf margins plane except near base; costa excurrent into a hair-point..... | 4. <i>systilius</i> . |

Sterile plants of *Pottia Randii* are hard to distinguish from *D. cernuus*. In general the leaves are less papillose and the costa less excurrent. The entire lack of peristome in *P. Randii* and the well developed peristome in *D. cernuus* is a very marked distinction with no intergradations known at present. The very large (35–59 μ) spores found in each are strikingly similar. The late John M. Holzinger considered them as conspecific.

1. DESMATODON LATIFOLIUS (Hedw.) Brid. Musc. Recent. Suppl. 4: 86. 1819.

Dicranum latifolium Hedw. Stirp. Crypt. 1: 89. pl. 33. 1789; Sp. Musc. 140. 1801.

Didymodon pilifer Wahlenb. Gl. Suec. (Ed. 2) 1: 754. 1826.

Trichostomum piliferum Hueben. Musc. Germ. 293. 1833 (except synonyms).

Trichostomum latifolium Lindb. De Tort. 224. 1864.

Tortula latifolia Lindb. Musc. Scand. 20. 1879.

Barbula latifolia Kindb. Eur. & N. Am. Bryin. 2: 252. 1897.

Plants tufted, green to brownish, reddish tomentose within; stems from a few millimeters up to (occasionally) 2 mm. long; upper leaves larger, oblong to somewhat spatulate, somewhat contorted when dry, 2.5–3 mm. long, broadly acute to nearly obtuse, concave; margins more or less revolute on one or both sides, papillose and entire; costa papillose on both faces above, nearly percurrent to excurrent into an almost smooth hair-point, in cross section showing median guides with a row of ventral cells nearly as large, a dorsal stereid band bordered by a larger row of dorsal cells; upper leaf cells quadrate-hexagonal to subrectangular up to 20 μ in longest dimension but usually less, obscured by many variously shaped papillae on both sides, some c-shaped; basal larger, smooth, rectangular to elongate-hexagonal, narrower near the margin; perichaetial leaves little different. Autoicous; antheridial buds a little below the perichaetium; seta erect, 1–2 cm. long, yellow, darker with age; capsule erect and symmetric or nearly so, oblong-cylindric, urn 1–2 mm. long, brown, chestnut colored when old; annulus of small cells, more or less persistent; peristome densely papillose, from a basal membrane extending above the annulus, the 16 teeth mostly split to near the base into two slender forks, sometimes more irregularly divided and connate at the joints; operculum obliquely rostrate, $\frac{1}{2}$ – $\frac{1}{3}$ the length of the urn, the elongated upper cells in erect rows; calyptra cucullate, descending well towards the capsule base; spores papillose, 18–24 x 30 μ , mature in summer. Type locality, Sweden or Lapland.

ILLUSTRATIONS:—Hedw. l. c.; Bry. Eur. pl. 129; Pl. 103, 104.

EXSICCATI:—Aust. Musc. Appal. 123; Bartram, Mosses of Southern Arizona 151. Macoun, Can. Musci 69.

Subarctic or subalpine; Greenland to Unalaska; south to Gaspé, California, Arizona and New Mexico; common in the Rocky Mountains.

1a. Var. *MUTICUS* Brid. Sp. Musc. 1: 207. 1806.

var. *glacialis* (Funck.) Schimp. Syn. (Ed. 1) 157. 1860.

Plants usually taller; upper leaves oblong-ovate, obtuse or apiculate; margins less revolute, costa not percurrent. Colorado and probably elsewhere. Similar leaves are often found on the lower part of typical plants. Bry. Eur. pl. 130; Pl. 104.

2. DESMATODON SUBERECTUS (Hook.) Limpr. Laubm. 1: 651. 1889.

Tortula suberecta Hook. in Drumm. Musc. Am. 145. 1828.

Desmatodon obliquus Bry. Eur. fasc. 18–20. pl. 136. 1843.

Plants tufted; stems branching, 5–10 mm. tall; leaves broadly ovate-lanceolate, the upper larger, about 2–3 mm. long by less than 1 mm. wide, gradually tapering from about the middle to a slenderly acute or acuminate apex, terminated by a nearly smooth hair-point, rarely over 0.25 mm. long; margins papillose, recurved most of their length; costa stout, excurrent into the hair-point, in cross section as illustrated, papillose on both sides in upper leaf; upper leaf cells quadrate to hexagonal, 12–15 μ in diameter, obscure with small, variously shaped papillae on both sides; lower cells smooth, pale, mostly rectangular or elongate-hexagonal; perichaetial leaves scarcely different. Paroicous, with antheridia in a cluster just below the archegonia; seta erect, up to 18 mm. long; calyptra extending about $\frac{1}{2}$ the way down the capsule; capsule oblong-cylindric, symmetric to slightly arcuate, urn about 2 mm. long; operculum long-conic, the upper cells elongate and very oblique; annulus inconspicuous, of small cells, persistent; peristome teeth from a basal membrane 0.05–0.07 mm. high, divided from near the base into two or three slender papillose forks, which are often more or less united and twisted about $\frac{1}{2}$ turn; spores rough, 18–24 μ , mature in midsummer. Type locality, Rocky Mts. of British America.

EXSICCATI:—Drumm. l. c.

ILLUSTRATIONS:—Bry. Eur. l. c.; Braithw. Brit. Moss. Fl. 1: *pl. 41E*; Dixon, Handb. Brit. Mosses (Ed. 3) *pl. 24G*; *Pl. 105*.

On calcareous substratum; Greenland, Beechey Id., Arctic America, Canadian and Colorado (Longs Peak) Rockies; very rare.

Drummonds 145, well illustrated by the Bry. Eur. plate seems clearly distinct from *D. latifolius* by the narrowly acuminate, gradually tapering leaves, smaller leaf cells and twisted peristome. A careful study of the rather scanty American and European material finds these differences intergrading to the extent that some plants are decidedly intermediate. This should be regarded as a subspecies of the much more frequent *D. latifolius* and *D. Guepini* as a reduced subspecies of the same.

3. DESMATODON GUEPINI Bry. Eur. fasc. 18–20. *pl. 133*. 1843.

Trichostomum Guepini C. Muell. Syn. 1: 590. 1849.

Barbula Guepini Schimp. Syn. (Ed. 2) 197. 1876.

Tortula Guepini Broth. in Engler & Prantl, Nat. Pflanzenf. 1³: 430. 1902.

A diminutive lowland plant much like *D. latifolius*; smaller in size, up to 3 mm. high; larger upper leaves only 1–1.5 mm. long; marginal cells usually a little less papillose than the median in the upper part of the leaf and sometimes more yellowish, the upper median 14–16 μ ; basal membrane of the peristome usually a little wider, forks of teeth narrower and longer; spores nearly smooth, up to 16 μ ; calyptra covering about $\frac{1}{2}$ of the capsule. Type locality, France. Known from France; California and New Mexico only.

ILLUSTRATIONS:—Bry. Eur. l. c.; Husnot, Musc. Gall. *pl. 26*; *Pl. 103, 106*.

In *D. latifolius* the marginal cells show numerous conspicuous papillae on most leaves; in *D. Guepini* these cells are usually smooth, but not always.

D. latifolius, *D. suberectus* and *D. Guepini* are so close to each other in characters that they are not easy to distinguish in a description. Had they not been accepted by so many European authors, one would hesitate to hold them distinct.

4. DESMATODON SYSTILIUS Bry. Eur. fasc. 31. Suppl. *pl. 131*. 1846. (See Williams l. c.)

Anacalypta latifolia var. *pilifera* Hook. in Drumm. Musc. Am. 70. 1828.

Much like *D. latifolius*; leaves broader, shorter and broadly ovate, not papillose, but cells more or less mamillate; margins plane above; hair-point averaging longer; operculum often remaining attached to the columella after dehiscence; spores larger, 20–32 μ , mature in midsummer. Type locality, Norway.

EXSICCATI:—Drumm. l. c.

ILLUSTRATIONS:—Bry. Eur. l. c.; *Pl. 103, 106*.

A rare alpine moss growing on humus; Greenland, Newfoundland, St. Paul Island, Canadian Rockies; Mt. Dana, California.

5. DESMATODON PLINTHOBIUS Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 94. 1856.

Desmatodon neomexicanus Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 95. 1856.

Plants densely cespitose; stems more or less branching, 3–4 mm. or more in length; leaves incurved-imbricate and somewhat contorted when dry, erect-spreading when moist, oblong-lanceolate to oblong-

lingulate, the upper at least twice as long as the lower, blade up to 2.5 mm. long, mostly obtuse, more rarely acute, sometimes almost emarginate; margins entire, for the most part strongly revolute from near the apex to below the middle; costa excurrent into a smooth hair-point often as long as the leaf blade, papillose on the back above, in cross section with about 4 guide cells with one or two rows of cells nearly as large on the ventral surface, a dorsal stereid band with outer cells little different; upper leaf cells obscure, subquadrate, about 8 μ wide, strongly papillose on both sides, with many C-shaped papillae among the others; lower cells rectangular, smooth, pale up to 16 x 40 μ ; perichaetial leaves little different. Usually dioicous; antheridial buds terminal to lateral by innovations just below the summit; seta erect, 6–12 mm. long; capsule oblong to cylindric, erect and symmetric or nearly so, *more or less apparently contracted below the mouth* even before dehiscence, urn up to 3 mm. long; calyptra cucullate, long-rostrate, covering about $\frac{1}{2}$ the urn; operculum long-conic to rostrate, occasionally nearly $\frac{1}{2}$ the length of the urn, with 2–3 rows of basal cells isodiametric, the upper elongate and somewhat oblique; *annulus large, compound, persistent*; peristome teeth, densely papillose, very irregular, more or less divided and perforate, varying greatly in length, up to 175 μ , usually much shorter, usually from a short basal membrane, sometimes divided into two nearly equal forks; spores smooth, 8–10 μ , mature in spring. Type locality, Charleston, S. Carolina.

ILLUSTRATIONS:—Sull. *Icones Musc.* pl. 30; M. H. M. f. 78; Pl. 103.

EXSICCATI:—Sull. & Lesq. l. c. and (Ed. 2) 123; Aust. *Musc. Appal.* 493. Holzinger's 233 & 233b are something else.

Walls, pavements, limestone rocks and calcareous soil; Pennsylvania to Illinois; south to Georgia, Alabama, Louisiana and Texas.

The small leaf cells, the large persistent annulus and the constriction below the capsule mouth will distinguish this from most similar species.

6. DESMATODON PORTERI James, in Aust. *Musc. Appal.* 123. 1870.

Barbula Egelingii Schleiph. *Flora*, 70: 222. 1887.

Barbula subcarnifolia C. M. & Kindb., in Macoun, *Cat. Can. Pl.* 6: 52. 1892.

Plants usually in compact tufts; stems 1–3 mm. long; leaves somewhat contorted and incurved when dry, spreading when moist, the upper up to 2 mm. long, oblong- to ovate-lanceolate, acute, often apiculate with one or two clear smooth cells; margins plane, *entire, bordered with a band of 2–3 rows of more elongated cells which are lighter colored and less densely papillose*, scarcely evident in young leaves; costa stout, nearly or quite percurrent, papillose on the back above, in cross section with a row of guides just below the ventral row of cells of nearly equal size and a dorsal stereid band with an outer dorsal layer of larger cells; upper leaf cells obscure with small papillae (some C-shaped) irregularly quadrate-hexagonal, 8–12 μ in longest dimension; lower cells smooth, pale, rectangular to elongate-hexagonal, reaching 120 x 20 μ near the base; perichaetial leaves little different. Dioicous; male plants smaller, intermingled with female; antheridial buds terminal or lateral by innovations; seta erect, 7–10 mm. long, rarely more, orange-yellow when young, darker with age; capsule erect, symmetric or nearly so, cylindric; urn about 2 mm. long; operculum conic-rostrate, 0.5–0.75 mm. long, with its upper cells somewhat oblique; annulus large and conspicuous, persistent; peristome papillose, from a basal membrane projecting above the annulus, irregularly divided into two, or rarely three, forks, these sometimes irregularly united, often oblique, reaching 0.75 mm.; spores smooth, about 8 μ in diameter, mature in early spring. Type locality, Easton, Pennsylvania (James).

ILLUSTRATIONS:—Sull. *Icones Musc. Suppl.* pl. 23; M. H. M. 164. f. 79; Pl. 103.

EXSICCATI:—Aust. l. c.; Holz. *Musc. Acro. Bor. Am.* 457.

On limestone rocks; Quebec, Ontario; south to Pennsylvania, Ohio, Indiana, Illinois and Missouri. Infrequent.

7. DESMATODON OBTUSIFOLIUS (Schwaegr.) Jur. *Laubm. Oesterr.-Ung.* 135. 1882.

Barbula obtusifolia Schwaegr. *Suppl.* 1: 129. 1811.

Desmatodon oblongifolius Hook. in Drumm. *Musc. Am.* 114. 1828 (nomen nudum).

Desmatodon arenaceus Sull. in Gray's *Manual* (Ed. 2) 628. 1856.

Desmatodon ohioense Schimp. *Syn.* (Ed. 1) 159. 1860.

Desmatodon subtorquescens C. Muell. & Kindb. in Macoun, *Cat. Can. Pl.* 6: 48. 1892.

Didymodon arenaceus Kindb. *Eur. & N. Am. Bryin.* 277. 1897.

Plants closely caespitose, 3–10 mm. high; stems more or less branching and radiculose at base; lower leaves small, the upper larger, 1–2 mm. long, erect-spreading, more or less crispate when dry, oblong-lingu-

late, broadly acute to rounded-obtuse, often apiculate; margin revolute, often nearly to apex, entire; *costa* stout, 60 μ or more wide in the upper middle, vanishing a little below the apex to percurrent and extending into the apiculus, smooth on the back or papillose above, in cross section as shown in *pl. 103. f. 5*; upper leaf cells, obscure, densely papillose with many C-shaped papillae, mostly subquadrate, 8–12 μ in longest dimension, gradually growing larger and smoother from a little above the middle to the base; median basal cells rectangular to elongate-hexagonal, up to 20 μ wide and 90 μ long, narrower toward the margin; perichaetial leaves little different, the inner sometimes smaller. Apparently dioicous; seta erect, up to 1 cm. in length, chestnut colored as is the mature capsule; capsule *oblong to cylindric*, nearly or quite erect and symmetric, urn 2–4 mm. long; operculum long-conic to obtusely short-rostrate, the upper cells somewhat oblique; *annulus of large cells, rather persistent*; peristome teeth pale, papillose, *variable*, from a basal membrane often slightly higher than the annulus, *usually divided into slender unequal prongs nearly to their base*, sometimes much reduced to rather short irregular lobes; spores smooth, 10–15 μ , apparently mature late summer to autumn. Type locality, Ohio.

ILLUSTRATIONS:—Sull. Icones Musc. *pl. 29*; Jennings, Mosses W. Pennsylvania, *pl. 13*; M. H. M. *pl. 34*; *Pl. 103*.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 93, (Ed. 2) 120; Holz. Musc. Acro. Bor. Am. 17.

On sandy soil and rocks; New Brunswick and Gaspé coast across the continent to Vancouver Island; south to Pennsylvania, Missouri, Arizona and California. Probably most frequent in the valleys of the Ohio and upper Mississippi rivers.

A careful examination of a relatively large number of specimens shows great variations in the size of plants and outline of leaf apices but there seems to be no constant array of characters to separate the European *D. obtusifolius* from the American plants which have been called *D. arenaceus*. Loeske (Annales Bryol. 7: 197. 1934) considers them to be distinct because *D. obtusifolius* is a lime lover and *D. arenaceus* is found on sandstone. Bearing in mind that sandstone is often cemented by lime compounds, this seems hardly sufficient to separate species. This species is sometimes confused with *Barbula unguiculata*, but the distinctly excurrent costa of the latter will serve to distinguish even sterile plants.

8. DESMATODON HENDERSONI (R. & C.) n. comb.

Didymodon Hendersoni R. & C. Bot. Gaz. 15: 40. 1890.

Closely caespitose; stems erect, branching chiefly by innovations, 1–2 cm. long; leaves crowded, spreading when moist, erect-imbricate and subincurved when dry, ovate to oblong-lanceolate, entire, 0.75–1.75 mm. long, rounded-obtuse to apiculate at apex, sometimes subacute; margins entire, revolute except at base and apex; costa stout, almost percurrent, often somewhat rough on the back above; in cross section with median guides and dorsal stereid band only; upper leaf cells distinct, small, 7–10 μ in longest diameter, irregular in shape and size, thick-walled, minutely papillose, the lower rectangular, longer near the costa, quadrate at the margins, smooth; perichaetial leaves oblong-lingulate, broadly obtuse, with costa ending farther below the apex in the inner. Seta reddish, 10–12 mm. long; capsule erect and symmetric or nearly so, subcylindric; urn up to 2 mm. or more long; operculum long-rostrate, about 1 mm. long; annulus distinct; exothecial cells elongate hexagono-rectangular; peristome teeth about 1 mm. long, very irregularly divided and joined (specimen scarcely mature) very finely papillose. Type locality, crevices of rock, Milwaukee, Oregon (L. F. Henderson). Also found at Arroyo Grande, California and near Seattle, Washington (*Piper*).

The costa structure definitely distinguishes this species from *Didymodon* and indicates *Desmatodon*.

ILLUSTRATIONS:—Bot. Gaz. l. c. *pl. 5C*; *Pl. 105C*.

9. DESMATODON CONVOLUTUS (Brid.) n. comb.

Trichostomum convolutum Brid. Sp. Musc. 1: 232. 1806.

Grimmia atrovirens Smith, Eng. Bot. *pl. 2015*. 1809.

Didymodon nervosus Hook. & Tayl. Musc. Brit. 66. *pl. 20*. 1818.

Desmatodon nervosus Bry. Eur. fasc. 18–20. *pl. 132*. 1843.

Tortula atrovirens Lindb. De Tort. 236. 1864.

Plants short, 2–5 mm. high, densely tufted, dark green; leaves close, spreading, imbricate and more or less spirally contorted when dry, oblong-ovate to subspatulate, concave, broadly and shortly acute, up to 2 mm. long; margins entire, strongly revolute; costa stout, percurrent to very shortly excurrent into a stout mucro, usually much thickened in the upper part, sometimes granulose on the upper surface, in cross section as illustrated, papillose on the dorsal side; upper leaf cells rounded-quadrate to irregular, varying consider-

ably in size, 10–18 μ , obscure, minutely papillose on both sides; lower and basal cells smooth, hyaline, rectangular, the marginal shorter. Autoicous; seta erect, reddish; seta 4–12 mm. long; capsule short-oblong to ovoid, erect and symmetric, 1.25–2 mm. long; operculum obliquely conic-rostrate, up to $\frac{1}{2}$ the length of the urn; annulus lacking; peristome teeth from a basal membrane about 60 μ wide, somewhat irregularly divided into two filiform prongs, strongly papillose, little or not at all twisted; spores 18–21 μ , smooth or finely punctate, mature in spring. Type locality, Switzerland.

ILLUSTRATIONS:—Bry. Eur. 1. c.; Braithw. Brit. Moss Fl. 1: *pl.* 31; Dixon, Handb. Brit. Mosses (Ed. 3) *pl.* 24H; Limpr. Laubm. 1: 662. *f.* 183; *Pl.* 105B.

EXSICCATI:—Bartram, Mosses S. Arizona 68; Baker, Pacific Coast Bryophytes 366. Holzinger's Musc. Acro. Bor. Am. 233 as *D. plinthobius* from Washington may be a form of this species, it certainly is not *D. plinthobius*.

On earth or stones; apparently frequent in Southern California and Arizona; also found in Lower California and elsewhere in Mexico; Europe, Australia, Asia, Africa.

If *Desmatodon* is to be treated as a genus separate from *Tortula* the only excuse for putting this species in *Tortula* would seem to be the distinct basal membrane. The no. 121, Sull. & Lesq. Musc. Bor. Am. (Ed. 2), referred to the var. *edentulus* Bry. Eur., seems to me to have a peristome broken rather than rudimentary

10. DESMATODON COLORADENSIS n. sp.

Plantae humiles, glauco-virides, gregariae; caulis plerumque simplex, \pm 1 mm. altus; folia superiora multo majora, 1 mm. longa, oblonga vel lingulato-oblonga, obtusa vel apiculata, concava, marginata; margine superiore integerrima vel papilloso-crenulata, aliquantum reflexa; costa sub apice desiniente vel in apiculum ingrediente; cellulis superioribus hexagono-quadratis, \pm 12 μ latis, utraque pagina valde papillosis. Setae 3–8 mm. longae; capsula oblonga vel cylindraceo-oblonga, erecta, \pm 1.3 mm. longa, late annulata; operculo e basi conica breviter rostrato; peristomio e membrana 120–150 μ lata, haud torto; sporis laevibus, \pm 9 μ .

Plants gregarious, light green, small; stems not over 1 mm. long, mostly simple, with central strand present; leaves oblong to lingulate, concave, the upper larger, reaching 1 mm. in length, obtuse and often apiculate; margins entire, somewhat reflexed, *unistratose*, bordered above by 2–3 rows of yellowish translucent and less papillose cells; costa strong, ending just below the apex or entering the apiculus, in cross section with a single dorsal stereid band, large ventral cells and inconspicuous guides; upper leaf cells obscure, strongly papillose with mostly C-shaped papillae, hexagono-quadrata, about 12 μ , reaching 15 μ in the longest dimension; *upper marginal cells rectangular, about 12 μ wide, reaching 22 μ in length but usually shorter, 1.5–2 : 1*; basal cells elongate-rectangular, smooth, clear, 30–70 \times 12 μ , shorter at the margin; perichaetial leaves larger, subsheathing. Probably dioicous; sporophyte light brown, darker with age; seta erect, 3–8 mm. long; capsule oblong to oblong-cylindric, urn up to 1.3 mm. long; operculum conic-rostrate, about $\frac{1}{2}$ the length of the urn, with cells of the beak subrectangular and oblique; annulus of large cells in about 2 rows, somewhat persistent and falling in pieces; *basal membrane of peristome 120–150 μ wide, the teeth divided into filiform, irregularly divided and anastomosing, papillose filaments, very fragile and usually much broken on dehiscence, scarcely twisted, reaching 180 μ in length; spores smooth, about 9 μ in diameter, mature in summer.* Type from Chucora Camps, Colorado, on rocks by brooks, Aug. 13, 1926 (*Mrs. F. A. MacFadden* no. 107). Type in herb. A. J. G. *Pl.* 108.

Easily distinguished from *Tortula marginata* by the unistratose margin, non-excurrent costa and shorter peristome. Aside from the border the leaves are much like those of some forms of *D. obtusifolius*.

11. DESMATODON SPRENGELII (Schwaegr.) Williams, Bull. Torr. Club. 46: 217. 1919.

Barbula Sprengelii Schwaegr. Suppl. 2: 64. *pl.* 119. 1824.

Plaubelia tortuosa Brid. Bryol. Univ. 1: 522. 1826.

Weisia Berteroana Sprengel, Syst. Veg. 4: 156. 1827.

Tortula Donnellii Aust. Bot. Gaz. 3: 31. 1878.

Barbula Donnellii Lesq. & James, Man. 128. 1884.

Desmatodon Garberi Lesq. & James, Man. 112. 1884.

Hyophila fragilis Card. Rev. Bryol. 36: 75. 1909.

Plants caespitose; stems simple, slender, 4–5 mm. long; leaves small and distant below, gradually somewhat larger and more crowded above, incurved when dry, spreading when moist, 1–1.5 mm. long, narrowly to broadly oblong-lanceolate, broadly acute to subobtuse and apiculate, entire or slightly serrulate near the

apex, margins incurved for a greater or less part above the base, often very much so, making the leaves subtubulose; costa stout, nearly or quite percurrent, sometimes slightly rough on the back above, in cross section with two to four guide cells, bordered by smaller cells on the ventral side and a dorsal stereid band; upper leaf cells usually rather obscure (Williams says distinct), irregularly hexagonal to roundish, 5–8 μ in diameter, mamillate on the ventral side, often strongly so, nearly flat dorsally; basal larger, smooth and quadrate to short-rectangular; perichaetial leaves little different. Dioicous, male flower terminal; antheridia about 0.3 mm. long among longer filiform paraphyses; seta erect, reaching 5 mm. long; capsule erect and symmetric, somewhat fusiform, urn 1–1.5 mm. long; operculum conic-rostrate, a little less to a little more than $\frac{1}{2}$ the length of the urn; stomata few, near the base; peristome teeth reddish-brown, papillose, irregular, jointed and varying in length, more or less divided, often nearly to the base, from a basal membrane of varying width, but never very wide; annulus well developed; spores smooth, 6–8 μ ; calyptra cucullate extending down the capsule $\frac{1}{2}$ its length or more. Type locality, Santo Domingo.

ILLUSTRATIONS:—Schwaegr. l. c.; Williams, l. c. pl. 11, figs. 8 & 9; Pl. 103, 108.
Florida, Mexico and the West Indies.

The leaves vary a great deal in width and the amount of marginal inrolling, the wider leaved forms are those referred to *D. Garberi* and *Hyophila fragilis*. Other than this the characters used to distinguish the two forms by Williams can be found on plants of the same tuft or even on the same plant.

Schwaegrichen describes the apex as entire, and so it is in many leaves. His illustration gives a much higher basal membrane than is credited or present in most specimens. Perhaps his microscope was not equal to ours. The division of the teeth is not constant even on the same plant, according to Williams. No fruiting plants have been seen from the U. S.

The type of *Tortula Donnellii* is mixed with *Tortula agraria* and *Hyophila tortula*.

12. DESMATODON CERNUUS (Hueben.) Bry. Eur. fasc. 18–20. pl. 134. 1843.

Dermatodon cernuus Hueben. Musc. Germ. 117. 1833.

Cynodontium latifolium Schwaegr. Suppl. 1: 110. 1817 (not *Dicranum latifolium* Hedw. Stirp. Crypt. 1: 89. pl. 33. 1787).

Tortula cernua Lindb. Musc. Scand. 20. 1879.

Desmatodon camptothecius Kindb., in Macoun Cat. Can. Pl. 6: 48. 1892.

Plants in rather compact cushions, from usually a few mm. in height to rarely 2–3 cm.; stems mostly simple, without central strand; stem leaves more or less erect and contorted when dry, oblong to oblong-spatulate, mostly 2–2.5 mm. long (Williams says up to 3.5 x 1 mm.), slenderly acute to almost obtuse and apiculate; upper margins plane and more or less irregular with projecting cells, of a single layer of cells, below more or less revolute on one or both sides, often of a double layer of 2–4 rows of linear somewhat colored cells; costa mostly excurrent into a rather short apiculus, in cross section showing 2–3 median guides with one or two rows of somewhat smaller ventral cells and a dorsal stereid band with larger outer cells; upper median cells rhomboidal to hexagonal, up to 18 x 37 μ , mostly finely papillose on both sides but occasionally nearly smooth, narrower at the margins; cells of the lower part smooth, lax, mostly rectangular, up to 30 x 100 μ or more; perichaetial leaves little different. Autoicous; antheridial bud just below the perichaetium; antheridia club-shaped, long-stalked; seta 1.5–2 cm. long, yellowish when young, dark red-brown when old; capsule ovoid, cernuus and unsymmetric; urn up to 1.75 mm. long; exothelial cells elongate-rectangular with a few rows of small cells around the mouth, called annulus by some authors; stomata in one row in the neck below the spore sac; peristome rather short, reddish brown, strongly papillose, each of the 16 teeth divided irregularly into two prongs, which are often perforate below, all united at base, 0.3–0.4 mm. long, not twisted; operculum obliquely short-rostrate, about $\frac{1}{2}$ the length of the urn, cells not obliquely arranged; calyptra cucullate, reaching the middle of the urn, smooth; spore large, coarsely papillose, 30–50 μ , in midsummer. Type locality, Austrian Tyrol.

ILLUSTRATIONS:—Schwaegr. l. c. pl. 28; Bry. Eur. l. c.; Limpr. Laubm. 1: 653. fig. 182; Dixon, Handb. Brit. Mosses (Ed. 3) pl. 24F; Pl. 107, 116, f. 11.

EXSICCATI:—Macoun, Can. Musc. 71, 604; Holz. Musc. Acro. Bor. Am. 557.

On soil and limestone débris, apparently calcicolous; Quebec to Alaska; south to Nevada, Colorado, N. Dakota, Wisconsin, and Ohio.

* The leaves of American plants tend to be less slenderly acute than the European as figured in the Bry. Eur. or even spatulate, which is probably the basis for Kindberg's *D. camptothecius*.

* See *Pottia Randii*.

13. DESMATODON LAURERI (Schultz) Bry. Eur. fasc. 18-20. *pl.* 135. 1843.*Trichostomum Laureri* Schultz, *Flora* 10: 163. 1827.*Tortula bryoides* Hook., in Drumm. *Musc. Am.* 135. 1828.*Tortula Laureri* Lindb. *De Tort.* 243. 1864.

An alpine or subarctic moss very closely allied to *D. cernuus*, differing chiefly as follows: plants usually somewhat larger and more branching; leaves 4-5.5 mm. long, more strongly papillose in the upper portion, with multiple papillae often horseshoe shaped; costa papillose on the back to below the middle, in cross section much the same but with the dorsal layer of cells smaller; margin more recurved above; leaf cells somewhat smaller, seta flexuous; capsule strongly inclined to pendulous, oblong, often nearly symmetric, up to 2.5 mm. or more in length; operculum longer, the cells obliquely arranged in the upper part; peristome longer, 0.5-0.6 mm. long, twisted about once around, less strongly papillose; spores 30-48 μ in diameter, in midsummer. Type locality, Austrian Tyrol.

ILLUSTRATIONS:—Bry. Eur. l. c.; *Pl.* 107; 116, *f.* 12.

EXSICCATI:—Drumm. l. c.

"On humus in rock crevices; Rocky Mts. from British Columbia to Colorado; Vancouver Island; Greenland; also in Europe and Asia."

9. TRICHOSTOMOPSIS Card. Rev. Bryol. 36: 73. 1909.

Plants small, caespitose; stems erect; leaves crowded, crisped when dry, erect-spreading when moist, larger near the top of the stem, narrowly lanceolate from a broader base, acuminate, obtusely acute, channelled; margins plane or slightly reflexed, entire *more or less bistratose* above; costa percurrent, *with only a dorsal stereid band*; upper cells smooth or papillose, rounded quadrate to hexagonal, lower larger, rectangular and hyaline, smooth; peristome of 16 teeth, divided nearly to the base into two filiform papillose divisions, as in *Barbula* but slightly or not at all twisted. Type species *T. crispifolia* Card. l. c.

This genus differs from *Barbula*, *Trichostomum* and *Didymodon* in the bistratose margins and single stereid band in the costa.

- | | |
|---|---------------------------|
| 1. Upper leaf cells 10-12 μ , papillose..... | 2. |
| Upper leaf cells 12-15 μ , merely mamilllose..... | 3. <i>Fayae</i> . |
| 2. Leaves narrowly acuminate; margins mostly plane..... | 1. <i>brevifolia</i> . |
| Leaves broadly acuminate; margins narrowly recurved in the median region..... | 2. <i>diaphanobasis</i> . |

1. TRICHOSTOMOPSIS BREVIFOLIA Bartram, Bryol. 34: 61. *pl.* 4. 1931.*Didymodon craspedophyllus* of Bartram from the U. S., not of Cardot, Rev. Bryol. 36: 81. 1909.*Didymodon diaphanobasis* var. *angustifolia* Thér. Bryol. 32: 8. 1929.

Plants short, dark green above; stems 1-2 mm. long, simple or branched; leaves crowded, the lower smaller, oblong-lanceolate, the upper linear-lanceolate, reaching 2 mm. in length, all rather blunt at the narrow apex; costa strong, percurrent; upper cells rounded quadrate-hexagonal, obscure, 10-12 μ in diameter, bistratose in patches above and on the upper margin, papillose with low blunt papillae; perichaetial leaves slightly shorter than those next below and more loosely areolate. Probably dioicous; seta red, erect, 7-9 mm. long; capsule erect and symmetric, cylindric to ovoid-cylindric; urn up to 1.5 mm. long; operculum conic-rostrate, blunt, up to 1 mm. long, with cells in oblique rows; annulus indistinct; peristome teeth divided to the base into two filiform papillose forks, up to 0.6 mm. long, these forks often grouped in fours, slightly twisted spirally; spores smooth, about 10-12 μ in diameter, mature in spring. Type from under shrubs on hill top, Tuna Canyon, Los Angeles Co., California, March 1931. (Mrs. Fay A. MacFadden, no. 8107.) Type in Herb. E. B. Bartram, A. J. Grout and the N. Y. Botanical Garden.

ILLUSTRATIONS:—Bryol. l. c.; *Pl.* 109.EXSICCATI:—Holz. *Musc. Acro. Bor. Am.* 636 (as *Didymodon craspedophyllus*).

I can find no valid differences between Mrs. MacFadden's plants and those identified by Bartram (doubtfully) as *Didymodon craspedophyllus* Card. from Arizona. (See Bryol. 30: 47. 1927.) The leaves of the Mexican *D. craspedophyllus* are flatter, wider above and more bluntly acuminate, with the thickened margin more distinct and upper cells about 6-8 μ . The peristome is rudimentary much as in *Weisia Andrewsii*.

2. TRICHOSTOMOPSIS DIAPHANOBASIS (Card.) n. comb.

Didymodon diaphanobasis Card. Rev. Bryol. 37: 125. 1910.

Differs from *T. brevifolia* in the taller plants, reaching 2–4 cm. in the sterile plants of the type, shorter in fertile plants, less than 1 cm.; leaves a little longer and much wider at the obtuse apex, with a larger area of hyaline and more elongate basal cells; margins more narrowly revolute in the median region, more narrowly bistratose. Urn of capsule up to 2.5 mm. long; peristome similar but reaching nearly 1 mm. in length; annulus persistent but clearly apparent; operculum long conic-rostrate, reaching 1 mm. Type locality Istacihuatl, Mexico. (Purpus no. 3721, in part, 1909; type seen) *Pl. 110*.

On soil or rocks; Alpine, Brewster Co., Texas (*Orcutt*, 7162a & 7163, 5,000 ft., May 31, 1926). The plants are dioicous, male mixed with the female; perigonal leaves short, ovate-acuminate, the inner ecostate, all strongly papillose above; paraphyses filiform.

Thériot considered *T. brevifolia* (*Didymodon diaphanobasis* var. *angustifolia*) as a var. of this species and he is probably right in considering them as one specific type. The excellent specimens from Mexico (Fr. Amable 1704 x in the New York Botanical Garden, com. Thériot) are in perfect fruit and abundant antheridia seem to make it certain that the two are at least congeneric.

3. TRICHOSTOMOPSIS FAYAE n. sp.

Plantae humiles, 3–5 mm. altae; folia superiora majora, ovato-lanceolata, ± 1.5 mm. longa, acuto-obtusa, sursum carinata, margine superiore recurvata, integra, bilamellata; cellulis superioribus $\pm 15 \mu$, regulae non consentaneis, orbicularis, utaque pagina \pm mamillolis, opacis; costa percurrente. Seta erecta, 1 cm. longa vel minore; capsula erecta, oblongo-cylindracea, ± 1.7 mm. longa, non annulata; operculo rostrato, ± 1 mm. longo; peristomio e membrana angusta, dentibus sedecim, fragilibus, fere ad membranum in crura duo capillaria papillosa tortaque fissis.

Plants small, the fertile stems up to 5 mm. long, usually shorter; leaves subimbricate and incurved when dry, erect-open when moist from a more or less erect base, the upper larger, crowded, ovate-lanceolate, obtusely acute, about 1.5 mm. long, keeled in the upper part, with bistratose margins more or less recurved, very entire; costa 120μ wide near the base, percurrent, in cross section with large median guides, with slightly smaller cells above and below and a few dorsal stereids; upper leaf cells averaging about 15μ , smaller near the margin, irregular and rounded, thick-walled, obscure, more or less rounded-mamilliose on both surfaces, papillose on the ventral surface of the upper costa; basal cells near the insertion rectangular, smooth, hyaline, reaching $60 \times 22 \mu$, smaller at the margins, gradually becoming shorter and smaller and merging into the upper; perichaetial leaves oblong-lanceolate, the inner with larger cells and often without chlorophyll. Probably dioicous; seta straight and erect, up to 1 cm. long, usually less; capsule usually erect and symmetric, oblong-cylindric, urn up to 1.7 mm. long; operculum long-rostrate, about 1 mm. long, with cells subspirally arranged; annulus not apparent; peristome teeth divided into two filiform prongs to a more or less perforate narrow basal membrane, papillose, segmented, a little shorter than the operculum, twisted $\frac{1}{2}$ turn or more; spores smooth, about 10μ , mature in May. Type from under shrubs, Syringia, Wash. near Sherman Way, Los Angeles Co., California, May 9, 1932 (Mrs. Fay A. MacFadden no. 8172). Type in herbarium of A. J. Grout. *Pl. 110B*.

10. TORTULA Hedw. Fund. Hist. Nat. Musc. 2: 92. 1782; Sp. Musc. 122. 1801 (in part).

WILLIAM CAMPBELL STEERE¹

Plants from very small to very large, in dense tufts or loose mats, rarely singly, growing usually on calcareous rocks or soils, more rarely on the trunks of living trees, bright, glaucous, or brownish-green, often

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with a tinge of red; stems erect, usually densely radiculose below, simple or branching either dichotomously or by means of innovations, a central strand of differentiated cells present or absent, often constant and of diagnostic importance, especially in the larger species; leaves commonly widest above the middle, usually oblanceolate, obovate, lingulate or spatulate, rarely oblong, elliptical, or ovate-lanceolate, usually larger and crowded in a rosette at the apex of the stem, little crisped or distorted but often regularly twisted about the apex of the stem and nearly always appressed when dry, erect to widely spreading when moist, more rarely recurved to squarrose-recurved; margin entire or nearly so, revolute throughout or in part, plane or somewhat incurved, usually not differentiated, in a few species bordered by a one- or several-layered band of thickened, colored, elongated, or otherwise modified cells; costa very well developed, from short, ending just above the middle of the leaf, to long-excurrent into an awn as long or longer than the lamina, rather variable in cross section, but almost always consisting of 2-6 large, median guide cells, a ventral row (or rows) of large cells, and a dorsal stereid band whose outermost row may or may not be differentiated; cells of upper leaf blade small, usually strongly papillose and obscure with several high, crescent-shaped or circular papillae, thick-walled, rarely unipapillate, or smooth and clear, or thin-walled; basal cells usually much larger, smooth, hyaline, yellow, or reddish, often in a clearly and suddenly differentiated group on each side of the costa.

Inflorescence monoicous, polygamous, or dioicous; perichaetial leaves (except in *T. amplexa*) very slightly or not at all differentiated; seta short to much elongated, straight, red, twisted when dry; capsule always exserted, erect, ovate to long-cylindric; urn straight to conspicuously curved, dark red or brown, becoming nearly black with age, rarely pale, smooth or striate when dry; calyptra long-beaked, the beak smooth or papillose, cucullate, variable in length and color; operculum usually long-rostrate, blunt or acute, sometimes somewhat oblique, rarely equalling the urn in length; annulus variable, revoluble and deciduous or persistent; peristome inserted below the mouth on a basal tube varying in length from a few microns to a long, pale, tessellated tube more than half the length of the whole peristome, peristome teeth 32, threadlike, papillose, red, pink, or yellow, wound spirally to the left in from less than one to more than two complete turns; spores very small, smooth to somewhat granulose.

Multicellular propagula of various sorts are not uncommon, occurring on the surface of the leaf lamina or costa, or in the leaf axils, and are occasionally of considerable diagnostic importance. Type species, *Tortula subulata* Hedw.

This genus has been defined very narrowly by some recent authors and very broadly by others. Dixon and Jameson (Student's Handbook of British Mosses, Ed. III, 1924) subordinated to *Tortula* such groups as *Pterygoneurum*, *Aloina* and *Desmatodon*. Amann (Flore des Mousses de la Suisse, 1912) not only accorded generic rank to *Pterygoneurum*, *Aloina* and *Desmatodon*, but also gave recognition to *Crossidium* and *Syntrichia* as genera and, still further, split off *Pachyneurum* from *Tortula* as a new genus, a treatment followed in large part by Mönkemeyer (Die Laubmoose Europas, 1927). Although the ancient genus *Syntrichia* is revived from time to time for many members of *Tortula* with a well-developed basal peristome tube, the presence of the same feature in species excluded from *Syntrichia*, even by those who use the name, breaks down the primary generic distinction.

According to the last list compiled (Brotherus in Engler & Prantl, Ed. II, 1924) there have been recognized throughout the world about 200 species of *Tortula*, of which a large proportion will eventually prove to be synonymous with species which are better known.

KEY.

- | | |
|---|--------------------------|
| 1. Plants bearing abundant propagula; most commonly growing on the trunks of living trees..... | 2. |
| Plants usually without propagula; growing on soil or rock..... | 6. |
| 2. Propagula borne in the axils of the leaves, at the apex of the stem..... | 14. <i>pagorum</i> . |
| Propagula borne on the surface of the leaf itself..... | 3. |
| 3. Propagula borne only on the upper surface of the costa..... | 13. <i>papillosa</i> . |
| Propagula borne only on the lamina..... | 4. |
| 4. Propagula elongated..... | 5. |
| Propagula spherical..... | 16. <i>latifolia</i> . |
| 5. Propagula borne on upper surface of leaf in the upper half only; costa percurrent... | 11. <i>caroliniana</i> . |
| Propagula borne on upper surface of leaf in the lower half only; costa ending not far above the middle of the leaf..... | 12. <i>propagulosa</i> . |

6. Leaf margin bordered more or less conspicuously with 1-6 rows of thicker-walled, colored, elongated, or otherwise differentiated cells. 7.*
 Leaf margin not bordered with differentiated cells. 10.
7. Differentiated cells of the border much elongated and often bistratose. 8. *subulata*.
 Differentiated cells of the border not conspicuously or at all elongated, always unistratose. 8.
8. Upper leaf cells smooth or nearly so, inner perichaetial leaves long and conspicuously sheathing. 5. *amplexa*.
 Upper leaf cells densely papillose, obscure. 9.
9. Costa long excurrent into a smooth awn. 1. *muralis*.
 Costa percurrent or ending below the apex. 4. *Bolanderi*.
10. Upper leaf cells not at all or only very slightly papillose. 11.
 Upper leaf cells conspicuously and densely papillose, often obscure or nearly opaque. 12.
11. Costa not reaching leaf apex; upper leaf cells about 8 μ in diameter. 6. *Williamsii*.
 Costa always excurrent as a short mucro or spine; upper leaf cells 18-28 μ in diameter. 9. *mucronifolia*.
12. Costa abruptly excurrent as a long awn sometimes equal in length to the rest of the leaf. 15.
 Costa percurrent, or excurrent as a very short mucro or apiculus, never an awn. 13.
13. Leaf apex very obtuse, broadly rounded or truncate; costa ending in or below the apex. 16. *latifolia*.
 Leaf tapering to an acute or obtuse apex, neither broadly rounded nor truncate; costa excurrent as a very short mucro. 14.
14. Leaves, especially the older ones, very fragile and brittle; margin revolute only in lower half; dioicous. 7. *fragilis*.
 Leaves not fragile; margin narrowly revolute nearly throughout; monoicous. 10. *inermis*.
15. Excurrent costa completely smooth. 16.†
 Excurrent costa slightly to very strongly serrate. 19.
16. Leaf margin somewhat revolute at the middle, otherwise plane. 15. *laevipila*.
 Leaf margin strongly revolute from base to apex. 17.
17. Basal leaf cells yellow; margin spirally revolute in one or more turns; leaf apex acute or subacute. 3. *aurea*.
 Basal leaf cells hyaline; margin revolute but not spirally so; leaf apex obtuse, truncate, or even emarginate. 18.
18. Capsule long-cylindric; peristome with a well-developed basal tube; dioicous; leaves not bordered. 2. *brevipes*.
 Capsule elliptical to short-cylindric; peristome with no basal tube; monoicous; leaves faintly to conspicuously bordered with larger, smoother cells. 1. *muralis*.
19. Leaves strongly squarrose-recurved when moist. 23.
 Leaves erect- to wide-spreading, but not squarrose-recurved when moist. 20.
20. Margins revolute from base to apex; plants conspicuously glaucous; excurrent costa often as long as the rest of the leaf. 22. *obtusissima*.
 Margins not revolute to apex, usually only in the lower half or two-thirds, or not at all. 21.
21. Leaf margins plane throughout. 17. *Bartramii*.
 Leaf margins revolute at least in part. 22.
22. Plants in loose tufts; monoicous; upper leaf cells 12-16 μ in diameter. 23. *princeps*.
 Plants in dense tufts or cushions; dioicous; upper leaf cells 8-10 μ in diameter. 18. *intermedia*.
23. Leaf margin revolute from base to apex; excurrent costa hyaline, at least in the upper half. 24.
 Margin plane in upper half or one third; excurrent costa red or reddish-brown throughout, often nearly smooth. 21. *norvegica*.

* *Desmatodon Porteri* may be sought here.

† *Desmatodon plinthobius* may be sought here.

24. Leaf apex obtuse to emarginate, the costa suddenly excurrent. 19. *ruralis*.
 Leaf apex gradually narrowed to an acute, dentate, hyaline point which runs into and joins the excurrent costa. 20. *ruraliformis*.

1. TORTULA MURALIS Hedw. Sp. Musc. 123. 1801.

Barbula muralis Web. & Mohr, Bot. Tasch. 206. 1807.

Plants densely caespitose, bluish- or glaucous green, often appearing hoary from the excurrent, hyaline costae; stems branching dichotomously, 5–15 mm. high, central strand present, well-developed; leaves infolded, incurved, and slightly to conspicuously twisted at the apex of the stem, but not much crisped, when dry, erect-spreading when moist, 2–3 mm. long, the upper elongate-ligulate to spatulate, obtuse, often emarginate, rarely shortly acute at the apex; margin broadly and tightly revolute completely to the apex, usually bordered with a row or two of more strongly thickened cells which are less papillose; costa very rough-papillose at the back, abruptly excurrent as a very long, smooth, hyaline, rarely yellowish hair, consisting in cross section of 2 median guide cells, about 4 ventral cells and several dorsal layers of stereids, whose outer row is differentiated toward the base; basal leaf cells hyaline, smooth, rectangular and linear, becoming much smaller above, roundish-quadrate, green, very densely and irregularly papillose on both sides. Monoicous. Seta straight, 1–2 cm. long, yellow at first, but becoming dark red with age; capsule erect, cylindric, usually somewhat curved, reddish-brown, becoming very dark; calyptra reaching the middle of the urn; operculum usually $\frac{1}{3}$ the length of the urn, narrowly conical, crenate at the margin, its cell rows spirally wound in several complete turns; annulus of 2–3 rows of cells, revolute; cells of the exothecium elongate-rectangular, shorter toward the mouth; tube of the peristome low, teeth 2–3 times spirally wound; spores usually 7–9 μ , yellow, smooth, ripening in spring. Type locality, Europe.

ILLUSTRATIONS:—Braithw. Brit. Moss-Fl. 1: pl. 31G, figs. 1–8; Dixon, Handb. Brit. Mosses (Ed. III) pl. 25B; Bry. Eur. pl. 159; Grout, Mosses with Hand-lens (Ed. III) pl. 34 and fig. 41; Hook. and Tayl. Musc. Brit. pl. 12; Husnot, Musc. Gall. pl. 28, figs. 1–8, pl. 29, figs. 9–13; Mönkemeyer, Laubm. Eur. fig. 64a; DeNot. Musci Ital. pl. 12, figs. 1–17; Roth, Eur. Laubm. pl. 2, figs. 1, 4–6, pl. 22, fig. 4a–e; Sim, Bryoph. of So. Africa, p. 230; Smith, English Bot. pl. 2033; Wilson, Bryol. Brit. pl. 12; M. H. M. fig. 76. EXSICCATI:—Drumm. Musci Am. S. States, 63; Austin, Musci Appal. 130; Ren. & Card. Musci Am. Sept. 164 (as *Barbula*); Holz. Musci Acro. Bor. Am. 16; Grout, Musci Perf. 14; Bartram, Mosses of So. Ariz. 137.

Growing on calcareous rocks, rarely on soil; widespread from New England south to the Gulf States, westward through the southern and central United States to California, where it is rare and replaced in large part by *T. brevipes* (Lesq.) Broth.

This common and variable species is most apt to be confused, when sterile, with *Desmatodon plinthobius* Sulliv., but that species has smaller leaf cells, no differentiated cells at the leaf border, and crescent-shaped or circular papillae, which are not irregularly verruculose as in *T. muralis*. There is a great deal of variation in the size of specimens, in the degree to which the leaf margin is revolute, in the length of the excurrent costa and even in the shape of the leaves, yet none of the variations seem to be stable enough to justify nomenclatorial recognition, even as varieties.

2. TORTULA BREVIPES (Lesq.) Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 431. 1902.

Barbula brevipes Lesq. Mem. Calif. Acad. Sci. 1: 12. 1868.

Barbula macrotricha Card. & Thér. Bot. Gaz. 37: 367. 1904.

Tortula macrotricha Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 1195. 1909.

Plants loosely to densely caespitose, bluish- to grayish-green, stems extremely short, to 3 mm., usually about 1 mm., unbranched; leaves densely crowded, infolded lengthwise, twisted spirally at the apex of the stem and somewhat crisped when dry, erect-spreading to widely spreading when moist, 2–3 mm. long, spatulate, lingulate or oblong-cuneiform, concave above, the apex obtuse to truncate; margins widely and tightly revolute in the upper two-thirds, with no perceptible border of thicker-walled or discolored cells; costa reddish-brown, finely papillose to nearly smooth on the back, abruptly excurrent into a long, hyaline, smooth awn to 1 mm. in length, in section consisting of 2 median guide cells, about 4 large ventral cells, and a dorsal band of stereids in several rows, the outer layer scarcely differentiated; basal leaf cells large, rectangular, hyaline, smooth, becoming smaller, roundish-quadrate to hexagonal, densely and irregularly verruculose-papillose on both sides, isodiametric above, about 15 μ in diameter. Dioicous (or very rarely monoicous?); male inflorescence terminal on much smaller plants; female inflorescence with paraphyses.

Seta erect, 15–18 mm. long, red below, yellow above; capsule erect, narrow, long-cylindric, the urn 3.5 mm. long, straight to somewhat curved, reddish-brown, becoming black with age; operculum about 1.5 mm. long, narrowly conic, obtuse, the cell-rows strongly twisted; annulus of 2–3 rows of cells; tube of the peristome conspicuous, $\frac{1}{3}$ to $\frac{1}{2}$ the length of the teeth, obliquely quadrate-tessellate, the teeth a dusty, glaucous red, twisted more than one full turn; spores yellow, smooth, 10–12 μ in diameter. Type locality, California.

ILLUSTRATIONS:—*Pl. 112.*

EXSICCATI:—Sull. & Lesq., Musci Bor. Am. (Ed. II) 143 (as *Barbula laevipila*); Baker, Pacific Slope Bryophytes 360 (as *Barbula muralis* forma *stenocarpa*); Holz. Musci Acro. Bor. Am. 233b (as *T. plinthobia*), 281; Grout, Musci Perf. 200.

Growing on calcareous soil, California to Washington, east to Utah (*Garrett*), Colorado, and Idaho, apparently taking the place, in large part, of *T. muralis* Hedw.

This species is closely related to *T. muralis*, but may be easily distinguished when in fruit by the very long capsule, which with the operculum may reach more than 5 mm., and by the well-developed basal tube of the peristome. The leaves are also somewhat wider, and the marginal row of cells is not noticeably differentiated, as in *T. muralis*. *T. brevipes* is apparently also closely related to the European *T. canescens* (Bruch) Mont., especially in the basal tube of the peristome, but differs in the more strongly revolute leaf margins and the longer capsules.

3. TORTULA AUREA Bartram, Bull. Torrey Bot. Club 51: 339. 1924.

Plants robust, in deep, rather loose cushions, yellowish-green above, light brown beneath; stems branched above or simple, sparingly radiculose below; leaves spirally twisted when dry, erect-spreading when moist, about 2 mm. long, ovate-lanceolate, tapering above to a sub-acute apex, cuspidate by the stout, excurrent costa which is occasionally prolonged into a smooth yellow hair-point half as long as the leaf; margins spirally once or more revolute from base to apex; costa light brown, strong, about 90 μ wide from base to apex, smooth, short- or long-excurrent, in cross-section showing 2 large median guide cells with one layer of about 3 somewhat smaller cells on the ventral side and a thick stereid band of 3 or more layers on the dorsal side with the outer row of cells somewhat larger; basal cells yellow, linear in the median part, 1 : 8 or 1 : 10, broader and shorter at the extreme base and short-rectangular to quadrate toward the margins with yellowish pellucid walls, gradually shorter above, in upper half quadrate-hexagonal, 10–12 μ in diameter, densely chlorophyllous and obscure with numerous papillae on both sides. Probably dioicous, male flowers not found, female flowers terminal or lateral by innovations; archegonia numerous, usually shrunken and unfertilized, with slender paraphyses. Sporophyte unknown. Type locality, Arizona.

ILLUSTRATIONS:—Bartram, Bull. Torrey Bot. Club 51: *pl. 6, figs. 1–11; Pl. 111.*

EXSICCATI:—Bartram, Mosses of So. Ariz. 98, 138; Holz. Musci Acro. Bor.-Am. et Eur. 649.

Mr. Bartram supplements the original description of this moss with the following notes: "Frequent and abundant on dry shaded ledges in the foothills of the Santa Catalina Mts. and the Tucson Mts. The absence of sporophytes leaves the relative position of this species rather uncertain but the characters in the aggregate seem to indicate a relationship to *Tortula muralis*, from any form of which it is abundantly distinct in leaf outline, spirally revolute margins and in the pellucid basal areolation without any suggestion of hyaline cells." Since the original description of *T. aurea* from Arizona specimens, the range of the species has been extended to western Texas, New Mexico and Mexico, through collections made by C. R. Orcutt.

4. TORTULA BOLANDERI (Lesq.) Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 430. 1902.

Barbula Bolanderi Lesq. Trans. Amer. Phil. Soc. 13: 5. 1865.

Plants gregarious, not tufted, dirty green to dark reddish-brown; stems short, 5–10 mm. high, simple or sparingly branched, central strand scarcely differentiated; leaves crowded toward the apex of the stem, rarely in interrupted rosulate or verticillate tufts along the stem as in *T. princeps*, imbricated and very slightly twisted about the apex of the stem, but little contorted when dry, stiffly erect-spreading when moist, oblong or lingulate, rarely spatulate or obovate, 1.5 to 2.5 mm. long, the apex blunt and concave; margins reflexed or narrowly revolute in the basal half, usually plane in the upper half, but occasionally revolute, conspicuously bordered from base to apex with 4–6 rows of thicker-walled, yellowish or reddish-brown cells in one layer; costa thick, yellowish or reddish-brown, smooth on the back, ending just below the blunt leaf apex, rarely very shortly mucronate, in cross section showing two very large median guide cells, 2 ventral cells and a dorsal band of 2–3 layers of stereids, whose outermost layer is not differentiated; basal leaf cells large, rectangular, lax, hyaline, except the marginal 4–6 rows which are narrower, thicker-walled and dis-

colored, upwards gradually becoming smaller, isodiametric, quadrate to hexagonal, the upper cells 8–15 μ in diameter, densely papillose and obscure, becoming smaller, thicker-walled, somewhat clearer and yellow or brownish toward the margin, which is crenulate-papillose. Dioicous, the inner perichaetial leaves not differentiated. Seta straight, dark red, 8–12 mm. long; capsule erect, cylindric, urn straight or slightly curved, about 2 mm. long, red, becoming very dark with age, irregularly striate when dry but not contracted below the mouth; operculum long-conic, somewhat obtuse, about half the length of the urn; annulus narrow, persistent; cells of exothecium rectangular; peristome teeth twisted in several complete turns, yellowish-red, papillose, from a very short, striate, papillose basal membrane; spores small, smooth or slightly granulose, 8–10 μ in diameter. Type locality, "near the Bay of San Francisco," California.

ILLUSTRATIONS:—*Pl. 112.*

EXSICCATI:—Sull. & Lesq., Musci Bor. Am. 139; Holz. Musci Acro. Bor. Am. 180 (as *Barbula amplexa*), 280, 499.

On rocks and soil, California to Washington.

This species seems distinct from all other North American species of *Tortula*, except the following, through the blunt leaves bordered with several rows of smaller, thicker-walled, yellower cells. It is apparently allied to *T. marginata* (Bry. Eur.) Spruce, but in that species the marginal cells are much elongated and bistratose.

5. *TORTULA AMPLEXA* (Lesq.) n. comb.

Barbula amplexa Lesq., Trans. Amer. Phil. Soc. 13: 5. 1865.

Plants densely gregarious, with a strong brownish or reddish tinge; stems short, 1–5 mm. long, central strand indefinite, branches few; leaves laxly appressed or irregularly spreading and somewhat crisped when dry, erect-spreading when moist, 1.5–2.5 mm. long, long-lingulate, apex obtuse or rarely sub-acute; margin entire, closely revolute nearly throughout or plane throughout, variable on the same plant, inconspicuously or conspicuously bordered by several rows of thicker-walled yellow cells which are isodiametric above and elongated below; costa yellow to reddish-brown, well-developed, ending in or just below the apex of the leaf, rarely slightly excurrent as a very short mucro, smooth on the back except very near the apex, where it may be sharply papillose, in cross section showing 2–4 rather thick-walled median guide cells, 2 ventral cells and about 2 rows of dorsal stereids, whose outer layer is differentiated only toward the base of the leaf, all cells of the costa showing collenchymatous thickenings in the cross section; leaf cells in the basal half of the leaf extremely lax, hyaline, rectangular, marginal cells longer, narrower, thicker-walled, sometimes with collenchymatous thickenings, yellow; upper leaf cells thin-walled, smaller, isodiametric, quadrate to hexagonal, 15–20 μ in diameter, becoming gradually smaller, thicker-walled, and discolored toward the margins, swollen or somewhat mamilliose and inconspicuously papillose to nearly smooth, very transparent. Dioicous; the inner perichaetial leaves long-linear-lanceolate, obtuse, erect, clasping at the base, deeply concave above. Seta straight, red, to 2 cm. long; capsule erect, short- to long-cylindric, the urn 1.5–2 mm. long, straight or slightly curved, pale yellowish- or reddish-brown, becoming darker with age, somewhat contracted below the mouth when dry; operculum long-conic, its rows of cells twisted in several turns, nearly equalling the length of the urn; annulus persistent; cells of exothecium rectangular, often much elongated; peristome teeth papillose, yellowish-red, becoming pale with age, closely twisted in several complete turns, from a very low, papillose, somewhat fenestrate basal membrane; spores small, smooth, yellowish-green, 8–10 μ in diameter, apparently ripening in late summer. Type locality, near San Francisco, California.

ILLUSTRATIONS:—*Pl. 112.*

EXSICCATI:—Sull. & Lesq. Musci Bor. Am. (Ed. II) 140; Lesq. Calif. Mosses 140.

The type material was collected "on stones, in springs near San Francisco," according to the Lesquereux and James Manual, and is still known from California only, although it has been reported from farther north.

T. amplexa is most closely related to *T. Bolanderi* (Lesq.) Broth., and field studies may eventually prove it to be only an ecological variation of that species. For the present, however, *T. amplexa* may be held separate on the basis of its much more lax areolation, sheathing inner perichaetial leaves, and poorer development of papillae on the leaf cells. The border of thicker-walled, yellow cells is even more marked than in *T. Bolanderi*, and often persists in old leaves after the tender tissue closer to the costa has disintegrated and completely disappeared. The capsule of *T. amplexa* is lighter in color and thinner-walled than in *T. Bolanderi*, and the seta is much longer. The species seems to prefer springs and dry washes where for part of the year it must receive considerable water.

6. *TORTULA WILLIAMSHII* Bartram, Bryol. 27: 70. 1924.

Plants in loose mats, yellowish to bright green above, light brown beneath, stems to about 1.5 cm. high, branched, upper part and innovations sparingly radiculose, without central strand; leaves 2–3 mm. long, loosely twisted and contorted when dry, erect-spreading when moist, ovate-spatulate from a narrow base, obtuse to suddenly bluntly acute; margins entire and plane above, narrowly recurved on one or both sides near the base; costa light brown, about 75 μ wide at base, tapering upward and vanishing below the apex of the leaf, in cross section near the middle of the leaf consisting of two median guide cells, with one layer of smaller cells on the ventral side and a thick stereid band of three or more layers on the dorsal side with the outer row of cells somewhat larger; upper leaf cells densely chlorophyllose and nearly opaque, smooth, more or less oval-hexagonal, about 8 μ in diameter, with very slightly and irregularly thickened walls, nearly uniform except at the extreme base where four or five rows near the costa are rectangular, 1 : 2 to 1 : 4, gradually becoming smaller and shorter towards the margins. Evidently dioicous; male flowers unknown; female flowers terminal, or lateral by slender innovations from just below the perichaetium; archegonia few, shrunken and unfertilized, with numerous slender, 4- to 6-celled paraphyses. Sporophyte unknown. Type locality, Santa Rita Mountains, Arizona.

ILLUSTRATIONS:—Bartram, Bryol. 27: pl. 11, figs. 1–10; Pl. 113.

EXSICCATI:—Bartram, Mosses of So. Ariz. 125; Bauer, Musci Eur. et Amer. Exsicc. 1833; Holz. Musci Acro. Bor. Am. et Eur. 548.

Mr. Bartram amplifies his original description of *T. Williamsii* with the following remarks: "Rather widely and abundantly distributed over the Santa Rita Mts., and the Patagonia Mts., on ledges in narrow shaded ravines above 5,000 ft. The plants are unusually distinct from any *Tortula* previously described from the United States and may represent the northern outpost of some subtropical species of Mexican distribution." This species is still known only from southern Arizona, where, however, Mr. Bartram has made numerous collections of it. It is one of the very few species whose leaf cells lack papillae. Although *T. mucronifolia* Schwaegr. also exists in Arizona, it may be distinguished by its larger size, excurrent costa and larger leaf cells.

7. *TORTULA FRAGILIS* Tayl. Lond. Journ. Bot. 6: 333. 1847
(not *T. fragilis* C. Hartm. Skand. Fl. (ed. 7) 377. 1858).

Barbula fragilis C. Müll. Syn. Musc. 1: 634. 1849 (not *B. fragilis* Wils. Bry. eur. Mon. Suppl. IV. p. 1. 1855).

Barbula Trianae Hampe, Ann. Sci. Nat. Ser. V. 3: 350. 1865.

Tortula confusa Card. Rev. Bryol. 36: 87. 1909.

T. Pringlei Card. Rev. Bryol. 36: 87. 1909.

T. fragilifolia Bartram, Bull. Torrey Bot. Club 51: 358. 1924.

Plants robust, in dense cushions, dark green above, reddish-brown below, lustrous throughout; stems 1–4 cm. high, branched above, closely matted together with reddish radicles; leaves infolded lengthwise and closely spirally incurved when dry, erect-spreading when moist, up to 3 mm. long, slightly concave, oblong-spatulate to ovate-oblong in outline, apex obtuse, shortly mucronate or apiculate by the somewhat excurrent reddish-brown costa; margins plane or narrowly revolute in the middle, distinctly crenately lobed in the upper half, often torn and broken in various ways; leaf cells large, rectangular and hyaline at the base, a well-defined area of larger cells with reddish-brown or orange walls in the median part, on either side of the costa, bordered by a marginal band of about six rows of much smaller, short-rectangular cells, quickly becoming shorter and hexagonal-quadrate above, the upper cells 10–12 μ in diameter, clearly arranged in rows and often in well-defined blocs, densely papillose on both sides with several crescent-shaped, round or forked papillae; costa reddish-brown, minutely but sharply papillose on the back, slightly mucronate-excurrent, in cross section consisting of two large median guide cells, about three smaller ventral cells in one or two layers and a thick dorsal stereid band of three or more layers with the outer cells little or not differentiated. Dioicous. Seta 8–14 mm. long, red; capsule erect, long-cylindric, about 4 mm. long, usually curved, with a conspicuous neck; calyptra hardly longer than the operculum; operculum about 1 mm. long, narrowly conical, blunt to acutish at the apex, its cell rows twisted in about one full turn; annulus of 2 rows; cells of the exothecium thin-walled, rectangular, becoming shorter toward the mouth; tube of the peristome about $\frac{1}{6}$ the length of the teeth, which are twisted about one full turn; spores about 10 μ in diameter, yellow, smooth or inconspicuously punctulate, apparently ripening in late summer. Vegetative propagation

through ecostate, ovate-acuminate, verrucose propagula in the form of imbricated brood-leaves which are borne on reduced branches found sparingly in the axils of the upper stem leaves. Type locality, Ecuador.

ILLUSTRATIONS:—Bartram, Bull. Torrey Bot. Club 51: pl. 7, figs. 1-11; Pl. 111.

EXSICCATI:—Bartram, Mosses So. Ariz. 87 (as *T. fragilifolia*), 71, 91 (as *T. alpina* var. *inermis*); Holz. Musci Acro. Bor. Am. et Eur. 574 (as *T. fragilifolia*); Bauer, Musci Eur. et Amer. Esx. 2113.

Growing on rocks and trees, apparently most common in Mexico and the American Southwest, but extending to Virginia (Leonard) and West Virginia (Gray).

Bartram (Bull. Torrey Bot. Club 51: 338) says of Arizona specimens of this species: "The dense cushions closely bound together by radicles, the very fragile structure of the lamina and the strongly crenately lobed margins would seem sufficient in the aggregate to give the plant a specific identity. It seems to be well distributed over the Santa Rita Mts. on bark near the base of oak trees above 6000 ft. but is more robust and characteristically developed at altitudes of 7500 ft. and over." Later, in speaking of a number of American specimens, Bartram (Bryologist 29: 53-54. 1926) says: "There seems to be a progressive tendency toward broader and shorter leaves as the northern limit of the range is approached, but a considerable variation in leaf-outline may be observed, even in the same collection, and it seems impossible to draw any satisfactory line of demarcation. The lamina may be so exceedingly fragile that only fragments remain attached to the persistent nerve or it may continue almost intact at the other extreme, but it invariably shows a brittle quality that is characteristic of the species. The detached fragments probably serve the same purpose as the propagula in so many other species of this genus. I have no direct evidence of the fact, but in several instances pieces under microscopical observation have shown a decided elongation of the marginal cells strongly suggestive of vegetative reproduction. Plants growing on a rock substratum seem to have a less fragile lamina than those found on the bark of trees."

A polymorphic and variable species, as the synonymy shows. The Arizona material matches fairly well the Argentina specimens collected by Hosseus and distributed by Bauer as No. 2113, cited above, but differs in shorter stems, more fragile leaves and shorter mucro. It is apparently most closely related to *Tortula alpina* var. *inermis*, which is not now recognized in North America. European bryologists do not seem to have recognized the brittle, fragile nature of the older leaves, which shows a closer relationship to *T. fragilis* than they have suspected.

8. TORTULA SUBULATA Hedw. Sp. Musc. 122. 1801.

Barbula subulata P. Beauv. Prodr. 43. 1805.

Plants densely caespitose in often extensive tufts, bright to glaucous green, discolored below; stems usually about 1 cm. high, rarely reaching more than 2 cm., branches few, densely radiculose below; leaves incurved, variously crisped and contorted when dry, erect-spreading when moist, crowded at the apex of the stem, oblanceolate to long-spatulate, acute, concave, 3.5-7.0 mm. long; margins plane, often reflexed at the base, bordered by 1-4 rows of longer, narrower, thicker-walled, papillose, yellow to reddish-brown cells in one or two layers, disappearing toward the leaf apex which may be slightly to conspicuously dentate; costa strong, yellowish-green to brown, inconspicuously papillose on the back, excurrent as a discolored spine, consisting in section of 2-4 large median guide cells, several large ventral cells and a several-layered dorsal band of stereids whose outer layer is not differentiated; basal leaf cells smooth, rectangular and hyaline, except for the yellow margin, upper cells quadrate to hexagonal, isodiametric, 13-18 μ in diameter, each cell strongly papillose on both sides with several high, curved papillae often grouped in circles. Monoicous. Seta 1-3.5 mm. long, red; capsule erect, very long-cylindric, urn to 7 mm. long, arcuate, reddish-brown; calyptra very large; operculum acutely conical, obtuse, $\frac{1}{2}$ - $\frac{1}{3}$ the length of the urn, about 2 mm. long, dentate at the margin; annulus of 2-3 rows of cells, persistent or deciduous in fragments; cells of exothecium rectangular; basal tube of peristome pale red, obliquely tessellate, always longer and sometimes twice as long as the teeth, which are red, papillose and twisted at least one full turn; spores about 12 μ in diameter, yellowish-green, smooth, ripening in spring. Type locality, Europe.

ILLUSTRATIONS:—Braithw. Brit. Moss-Fl. 1: pl. 32B, figs. 1-8; Bry. Eur. pl. 160; Dixon, Handb. Brit. Mosses (Ed. III) pl. 25D; Hedw. Sp. Musc. pl. 27, figs. 1-13; Schwaegr. Suppl. 1: pl. 34, figs. 1-7; Hook. & Tayl. Musc. Brit. pl. 12; Husnot, Musc. Gall. pl. 32, figs. 1-13; Limpr. Laubm. fig. 184; Mönkemeyer, Laubm. Eur. fig. 64c; DeNot. Musci Ital. pl. 21, figs. 1-16; Roth, Eur. Laubm. pl. 17, fig. 9, pl. 24, fig. 5a-d; Smith, English Bot. pl. 1101; Warnstorf, Kryptogamenfl. Mark Brandenb. 2: 45, fig. 16, 279, fig. 9a-b; Wilson, Bryol. Brit. pl. 12; Pl. 116.

EXSICCATI:—Macoun, Canad. Musci 217, 610 (as *Barbula*), 217a (as *Barbula subulata* var. *longifolia*); Canad. Crypt. 22, 217a (as *Barbula subulata* var. *longifolia*); Flora Canad. 2103 (as *Barbula*); Holz. Musci Acro. Bor. Am. 338.

On soil, California to British Columbia.

In its characteristic form, this species is completely unmistakable. The densely papillose, opaque leaves, bordered with longer, yellow or reddish-brown cells, and the very well developed basal tube of the

peristome present a combination of features found in no other species of *Tortula*, yet most of the specimens labelled "*T. subulata*" in American herbaria are actually *T. mucronifolia*, *T. inermis* or some other species.

8a. Var. *ANGUSTATA* (Wils.) Limpr. Laubm. 1: 671. 1888.

Tortula angustifolia Wils. in Lindb. de Tort. 243. 1864.

Closely resembling the American form of *T. subulata*, from which it differs in the taller and more slender habit, the longer, narrower leaves narrowed to a more acute apex, the border distinct completely to the leaf apex, which is more conspicuously toothed. In the sporophyte, the seta and capsule tend to be more slender.

ILLUSTRATIONS:—Braithw. Brit. Moss-Fl. 1: pl. 32C, figs. 1-8; Dixon, Handb. Brit. Mosses (Ed. III) pl. 25E; Pl. 116.

I have seen several specimens from California which matched European specimens very closely. Material identified as *T. angustata* from other places has all turned out to be something else. So many intermediate forms exist between this plant and *T. subulata* that the former cannot safely be given specific rank, nor even recognized as a subspecies, especially since it is not separated geographically from the species.

9. *TORTULA MUCRONIFOLIA* Schwaegr. Suppl. 1¹: 136. 1811.

Barbula mucronifolia Bryol. Eur. Mon. p. 38. 1842.

B. subcuneifolia Kindb. Rev. Bryol. 23: 22. 1896.

Tortula subcuneifolia Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 430. 1902.

Barbula brachypoda Card. & Thér. Wash. Acad. Sci. 4: 303. 1902.

Tortula brachypoda Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 1195. 1909.

T. gelida Mitt. in herb.

Plants densely caespitose, a clear bluish-green to dark green; stems branching through innovations, to 10 mm. long; leaves incurved at the apex, crisped and twisted when dry, erect-spreading when moist, crowded, long-spatulate, acute to acuminate, about 3 mm. long; margin usually closely revolute toward the base, often inconspicuously bordered in the lower part with several rows of longer, yellow cells; marginal cells in the upper part rarely thicker-walled or slightly papillose, almost never elongated; costa conspicuous in dry plants, excurrent as a yellow mucro or longer excurrent as a yellow spine, occasionally somewhat dentate at the base, smooth on both sides, consisting in section of 2 median guide cells, 2-4 ventral cells in 2 layers, and a dorsal band of stereids; basal leaf cells elongated, hyaline, becoming shorter above, quadrate to hexagonal, 18-28 μ in diameter, slightly smaller toward the margins, rarely thicker-walled and somewhat discolored; trigones well developed and often conspicuous, smooth or rarely with a few low papillae, often very convex-bulging, always clear and transparent. Monoicous. Seta 1-2 cm. high, red; capsule erect, dark brown, the urn long-cylindric, straight or slightly curved, 3.5-6 mm. long; operculum long-conic, $\frac{1}{8}$ - $\frac{1}{2}$ the length of the urn, to 2 mm. long; annulus of 2-3 rows of cells, persistent; basal tube of the peristome white or pink, nearly equalling the red, closely-twisted teeth in length; spores 14-18 μ in diameter, yellow-green, finely punctate, ripening in late summer. Type locality, Switzerland.

ILLUSTRATIONS:—Broth. Laub. Fennosk. fig. 20M; Bry. Eur. pl. 162; Husnot, Musc. Gall. pl. 32, figs. 1-6; DeNot. Musci Ital. pl. 22, figs. 1-14; Roth, Eur. Laubm. pl. 24, fig. 1a-c; Schwaegr. Suppl. l. c. pl. 35, figs. 1-6; M. H. M. pl. 36.

EXSICCATI:—Sull. Musci Allegh. 147 (as *Barbula*); Sull. & Lesq. Musci Bor. Am. (Ed. I) 99, (Ed. II) 141 (as *Barbula*); Drumm. Musci Am. 144 (as *T. subulata*); Austin, Musci Appal. Suppl. 497 (as *T. subulata*); Macoun, Canad. Musci 80 (as *Barbula*); Flora Canad. 2097 (as *Barbula*); Canad. Mosses 70a (as *T. subulata angustata*), 80 (as *T. subulata*); Clements, Crypt. Format. Colo. 195 (as *Barbula subulata*); Bartram, Mosses of N. Mex. 34 (as *T. subulata*); Holz. Minnesota Mosses 62 (as *Barbula*), Mosses of Colorado 12, Musci Acro. Bor. Am. 88; 648 (as *T. alpina*); Grout, Musci Perf. 163.

A common and widespread species growing on soil and rocks; Greenland across the Arctic Archipelago to Alaska, southward to New York, Iowa, New Mexico, Arizona and California; very rare on the Pacific Coast, where its place seems to be taken by *T. subulata*. According to Limpricht and other European bryologists this is an alpine and boreal moss of rather restricted distribution in Europe, whereas in North America it is not at all limited to high altitudes and latitudes, but is abundant almost throughout the northern and western United States, with the exception of the Pacific Coast. The natural suspicion that the North American moss might be a species different from the European one is not substantiated by a comparison of specimens, as they agree in nearly all respects. American specimens vary much more greatly in size, often reaching in every part more than twice the size of European specimens. Toward the north the plants become reduced in size and approach European specimens more closely. There has been a very general confusion of *T. mucronifolia* with *T. subulata*, in this country. To be sure, the upper leaf cells of

T. mucronifolia are obscurely to rather conspicuously papillose in many specimens, as pointed out to me many years ago by Mr. H. R. Becker, but the cells never lose their transparency. The geographic ranges of the two species are very distinct, overlapping to some extent only in the Pacific Northwest, where somewhat intermediate forms naturally occur. In general, however, the two species are abundantly distinct, as a comparison of authentic specimens will show.

10. *TORTULA INERMIS* (Brid.) Mont. Arch. Bot. 1: 136. 1832.

Barbula inermis C. Müll. Syn. Musc. 1: 624. 1849.

Tortula subulata var. *inermis* Spruce, Ann. Mag. Nat. Hist. 2: 376. 1849.

Plants densely caespitose, bright bluish-green to very dark green, becoming darker below; stems to 2 cm. high, little branched; leaves folded lengthwise, incurved, appressed, contorted and characteristically spirally coiled or twisted when dry, erect to erect-spreading when moist, crowded at the apex of the stem, long-lingulate, shortly acute, usually obtuse, concave, 2.5–5 mm. long, rarely reaching 1 mm. in width; margin entire, not bordered, narrowly but conspicuously revolute throughout, strongly papillose-crenulate; costa red-brown, very thick, densely papillose on both sides, ending in the leaf apex or excurrent as a very short apiculus, consisting in cross section of 2–4 median guide cells, 2 layers of large ventral cells, and a many-layered dorsal stereid band, of which the outer layer is not or only slightly differentiated; basal leaf cells rectangular and hyaline, a few at the extreme margin shorter and yellow, upper leaf cells roundish-quadrate to hexagonal, isodiametric, 12–16 μ in diameter, thickened at the angles, very densely multi-papillose on both sides with high, curved or crescent-shaped papillae. Monoicous. Seta 15–25 mm. long, reddish-brown; capsule erect, narrowly cylindric, the urn averaging about 4 mm. long, curved, dark reddish-brown, becoming purplish-black with age; operculum one-third the length of the urn, about 1.5 mm. long, long-conic, acute, margin dentate, red; annulus of 2–3 rows of cells; cells of exothecium long-rectangular, the long walls more strongly thickened; basal tube white, densely papillose, one-third to one-half the length of the peristome, which reaches nearly 2 mm., the teeth pale, papillose, twisted more than one full turn; spores 10–12 μ , yellowish-green, minutely granulate, maturing in spring. Type locality, France.

ILLUSTRATIONS:—Bry. Eur. pl. 167; Husnot, Musc. Gall. pl. 32, figs. 1–5; Mönkemeyer, Laubm. Eur. fig. 63g; DeNot. Musci Ital. pl. 20, figs. 1–12; Roth, Eur. Laubm. pl. 24, fig. 3a–c; Pl. 103.

EXSICCATI:—Sull. & Lesq. Musci Bor. Am. (Ed. I) 99b, (Ed. II) 142; Holz. Musci Acro. Bor. Am. 521; Bartram, Mosses of So. Ariz. 10, 93.

On rocks and soil throughout the southwest; California, Nevada, Utah, Wyoming, Colorado, Arizona, and New Mexico.

This species is close to *T. subulata*, but easily distinguished by the short costa and leaf margins narrowly revolute from base to apex. The leaves of dry plants have a very curious and characteristic coiled appearance. The monoicous inflorescence and high, white basal tube of the peristome will serve to distinguish this from other species with sub-acute leaves and a percurrent or mucronate costa.

11. *TORTULA CAROLINIANA* Andrews, Bryol. 23: 72. 1920.

Plants densely caespitose, bright green above, brown below; stems strong, sparingly branched, up to 10 mm. long, but rarely more than 5 mm., radiculose below, round in section, the outer 2–3 rows of cells gradually smaller and thicker-walled than those within, central strand present; leaves incurved and somewhat crisped when dry, erect-spreading when moist, obovate, averaging about 2.5 mm. long, reaching 1 mm. wide in widest part, margins strongly reflexed in the basal half, apex abruptly apiculate, but the costa only percurrent; costa brown to red, very conspicuous in dry plants, slender, averaging about 50 μ in width in lower part of leaf, smooth on the back, consisting in section of two guide cells with two ventral cells of nearly equal size adjoining them, and a dorsal area of uniform stereid cells; basal leaf cells smooth, rectangular, the outer ones narrow and somewhat chlorophyllose, up to 50 x 10 μ , in region of costa larger, hyaline with brown walls, up to 70 x 25 μ , upper leaf cells irregularly roundish-quadrate to polygonal, isodiametric, averaging about 15 μ in diameter, with fairly thick walls and distinct trigones, near the margin slightly smaller and with thicker walls, but never giving the impression of a distinct border, papillose on both surfaces with regularly crescent-shaped or rarely circular papillae, normally 4 per cell on each side, rarely more than 6, in smaller cells of border region often 2 or 3, rather low in profile and entirely independent of each other, the wall to which they are attached not at all thickened. Sex organs and sporophyte completely unknown. Vegetative propagation by means of very numerous propagula, more or less cylindrical in shape, with rounded ends, produced from and perpendicular to the ventral surface of upper half of leaf blade, the

cells from which they originate generally slightly smaller than those surrounding them, often lacking chlorophyll and with papillae less distinct or lacking; propagula densely chlorophyllose, somewhat roughened on outer surface, multicellular, divided by parallel planes at right angles to the long axis at intervals of 20–25 μ , up to 8 divisions, these divisions often further subdivided into 2–4 parts by planes at right angles, the end segments usually smaller and undivided, the whole propagulum varying in width up to 45 μ and the length up to 200 μ or more. Type locality, Swannanoa, Buncombe County, North Carolina.

ILLUSTRATIONS:—Andrews, Bryol. 23: plate 5, figs. 1–10; Pl. 113.

EXSICCATI:—Holz. Musci Acro. Bor. Am. & Eur. 625; Pringle, Plantae Mex. 10449 (in part), 10618 (in part), 15308 (in part).

Plants growing on bark of deciduous trees (beech, oak, chestnut); North Carolina, Tennessee, Mexico, Costa Rica.

This species differs most strikingly from *T. papillosa* Wils. in the recurved basal margins, the percurrent (not excurrent) costa, the very different papillae, and the much larger propagula arising from the ventral leaf surface rather than entirely from the ventral surface of the costa. According to Sharp (Bryologist 36: 20. 1933) some of the Mexican specimens of *T. caroliniana* (Pringle 10618, for example) have propagula on both surfaces. *T. pagorum*, of course, produces its propagula in the leaf axils and in the terminal bud. For the differences from *T. propagulosa* see the description of that species.

12. TORTULA PROPAGULOSA Sharp, Bryol. 36: 20. 1933.

Plants gregarious to densely caespitose, dark green above, blackish below; stems slender, very short, rarely over 5 mm. in height, rather freely branching, round in cross section, central strand rudimentary or lacking; leaves 1.0–1.5 mm. long, to 0.3 mm. wide, incurved at the apex when dry, but scarcely crisped; spatulate, the apex obtusely acute to acute; margins plane throughout, not bordered; costa conspicuously white in dry specimens, very short and delicate for the genus, from one-half to two-thirds the length of the leaf, never percurrent, 55 μ in width in the lower part, smooth, in cross section with 2 ventral guide cells and 9–13 dorsal stereids; basal leaf cells rectangular, up to 50 x 25 μ , smooth except for the pedicels upon which the propagula are borne, median and upper leaf cells more densely chlorophyllose, smooth, often bulging, roundish-quadrate to hexagonal, isodiametric, averaging about 25 μ in diameter, cell walls slightly thickened, with indistinct trigones. Sex organs and sporophyte completely unknown. Vegetative reproduction by means of basal innovations and numerous, generally cylindrical, smooth, densely chlorophyllose, multicellular propagula, divided at right angles to their long axis, about 40 μ wide, up to 200 μ long; the propagula-producing cells differentiated only by the papilla-like spurs which bear the propagula. Type locality, Knoxville, Tennessee.

ILLUSTRATIONS:—Sharp, Bryol. 36: pl. 1, figs. 1–5; Pl. 116.

EXSICCATI: Grout, Musci Perf. 255; Verdoorn, Musci Sel. et Crit. 99.

Growing in soot-filled crevices of bark of elm; still known only from several parts of Knoxville, Tennessee, the type locality.

The short costa and complete lack of papillae separate this species from all other similar ones. *T. caroliniana* Andrews approaches *T. propagulosa* more closely in macroscopic character than any other species, but may be distinguished at once by the percurrent costa in the leaves and by the papillose propagula and leaf cells.

13. TORTULA PAPILLOSA Wils. Spruce, in Lond. Journ. Bot. 4: 192. 1845.

Barbula papillosa C. Müll. Syn. Musc. 1: 598. 1849.

Plants occurring singly or in very small but dense tufts, dark green, brownish when dry; stems short, reaching 10 mm., but rarely surpassing 5 mm., branching; leaves incurved at the apex and imbricated when dry, hardly crisped, spreading widely when moist, broadly obovate to spatulate, about 2 mm. long, reaching 1 mm. in width at the widest part, rounded, truncate, or retuse at the apex, margins involute when dry, plane or nearly so when moist; costa thick and spongy, pale, very conspicuous in dry plants, strongly spinose- to stellate-papillose on the back, propaguliferous on the ventral side, in the upper part, especially in young leaves, excurrent into a mucro or short, smooth awn, in cross section consisting of 2 median guide cells, about 4 large ventral cells and a dorsal group of stereids; basal leaf cells rectangular, hyaline toward the costa, upper leaf cells rounded quadrate to polygonal, 20–25 μ in diameter, with rather thick and conspicuous trigones, transparent, often nearly smooth on the upper side but short to spinose-papillose on the back. Reproduction through oval or roundish multicellular propagula of a bright yellowish-green, borne on short pedicels, very numerous on the younger leaves but usually lost on the older ones, 50–80 μ in diameter. Sporophyte unknown in the northern hemisphere. Type locality, England.

ILLUSTRATIONS:—Braithw. Brit. Moss-Fl. 1: *pl. 32E, figs. 1-11*; Broth. Laubm. Fennosk. *fig. 29G-H*; Dixon, Handb. Brit. Mosses (Ed. III) *pl. 26C*; Grout, Bryol. 7: *pl. 8, figs. 1-2*; Husnot, Musc. Gall. *pl. 33, figs. 1-6*; Limpr. Laubm. 1: *fig. 185*; Mönkemeyer, Laubm. Eur. *fig. 64e*; Roth, Eur. Laubm. *pl. 1, fig. 10, 13, pl. 25, fig. 2a-c*; Sim, Bryoph. So. Africa p. 226; Warnstorf, Kryptogamenfl. Mark Brandenb. 2: 279, *fig. 7a-c*; Wilson, Bryol. Brit. *pl. 44*; M. H. M. 167. *f. 79b*.

EXSICCATI:—Sull. & Lesq., Musci Bor. Am. (Ed. I) 95c, (Ed. II) 127; Austin, Musci Appal. 133; Holz. Musci Acro. Bor. Am. 235.

On the bark of living trees (especially elms); apparently most common in the northeastern states, ranging south to Virginia and North Carolina (Anderson), west to Michigan (Schnoberger) and Illinois. A single collection from California, correctly identified, has been seen, but no collections have apparently been made in the intervening territory.

This species is not apt to be confused with any other corticolous species because of the leaf margins involute when dry and the abundant gemmae borne directly on the upper surface of the rather fleshy costa. The leaf cells are unique in the genus for their single, simple papillae.

14. TORTULA PAGORUM (Milde) DeNot. Epil. Briol. Ital. 542. 1869.

Barbula pagorum Milde, Bot. Zeit. 20: 469. 1862.

Tortula laevipila (Brid.) DeNot. var. *propagulifera* Lindb. de Tort. 245. 1864.

Tortula alpina (Bry. Eur.) Bruch, var. *propagulifera* Limpr. Laubm. 1: 683. 1888.

Syntrichia laevipila Brid. var. *pagorum* Mönkem. Laubm. Eur. 309. 1927.

Plants densely caespitose in small to extensive mats or cushions, very fragile, clear green, becoming darker when dry, often with a reddish tinge; stems up to 10 mm. high, but usually less than 5 mm., radiculose at base, central strand present but somewhat indefinite; leaves mostly in a terminal rosette, the lowermost very small, incurved and closely appressed when dry, not crisped, but often slightly twisted, erect-spreading when moist, obovate, lingulate or panduriform, concave above, 2.0-2.5 mm. long (including awn), about 1 mm. wide, at the apex rounded, truncate or rarely retuse; leaf margin plane, not bordered, rarely slightly inflexed, strongly papillose-crenulate; costa pale red, thick, smooth on the back, excurrent as a smooth or rarely somewhat roughened awn, up to 1 mm. long, very conspicuous in dry plants, in cross section showing 2 median guide cells, 2 ventral cells of nearly equal size, and a larger dorsal stereid group; basal leaf cells hyaline, with yellow walls, the cross walls often thickened, rectangular toward the costa, shorter toward the margins, cells of the upper three-quarters of the leaf much more densely chlorophyllose, roundish-quadrate to hexagonal, isodiametric, about 12 μ in diameter, papillose with numerous high, crescent-shaped or circular papillae. Dioicous; archegonial plants not uncommon; antheridial plants unknown in our range. Sporophyte completely unknown. Vegetative reproduction through lanceolate to elliptic and ovate densely papillose or verrucose, ecostate, leaf-like propagula with a smooth or faintly papillose hyaline apical spine, produced at the apex of the stem and in the axils of the comal leaves, 200-250 μ \times 80-100 μ . Type locality, Switzerland.

ILLUSTRATIONS:—Limpr. Laubm. 1: *fig. 186*; Jaeggli, Boll. Soc. Ticinese Sci. Nat. 1933: 11; Bryol. 7: *pl. 8, figs. 3-5*; 23: *pl. 1, figs. 1-4*; 23: 33, *fig. 1*; 33: 41, *fig. 1, 42, fig. 2*; Bartram, Bull. Torrey Bot. Club 51: *pl. 7, figs. 12-17*; Mönkemeyer, Laubm. Eur. *fig. 63f*; Roth, Eur. Laubm. *pl. 25, fig. 3a*; *Pl. 114*.

EXSICCATI:—Small, Mosses of Southern States 39 (as *T. papillosa*); Holz. Musci Acro. Bor. Am. 360, 500; Bartram, Mosses So. Ariz. 15; Grout, Musci Perf. 191; Verdoorn, Musci Sel. et Crit. 98.

On the trunks of living trees, very rarely on rocks, Ohio, West Virginia and Maryland, south to Georgia, west to Oklahoma, Texas, Arizona and California.

The taxonomic status of this moss has been much debated, and its identity as a species not always recognized, as the synonymy listed above will show. Most American authors have considered this distinct enough from *T. laevipila*, especially in the propagula and dioicous inflorescence to merit specific rank, and recent European investigations seem to substantiate such a treatment (cf. Jaeggli, Boll. Soc. Ticinese Sci. Nat. 1933: 1-11).

T. pagorum is distinct from the other corticolous, propaguliferous *Tortulae* in that its propagula are borne at the apex of the stem or in the axils of the upper leaves, but not on the costa or surface of the leaves themselves, as in *T. papillosa*, *T. caroliniana*, and *T. propagulosa*. The leaf cells of *T. papillosa* bear on their dorsal surface only one large papilla, whereas in *T. pagorum* the cells are multi-papillose on both surfaces with small, crescent-shaped or circular papillae.

15. TORTULA LAEVIPILA (Brid.) Schwaegr. Suppl. 2: 66. 1823.

Syntrichia laevipila Brid. Musc. Recent Suppl. 4: 98. 1819.

Barbula laevipila Bry. Eur. Mon. p. 40. 1842.

Plants caespitose, usually densely so, dark green to brownish; stems to 3 cm. high, usually 1-2 cm., radiculose at the base, dichotomously branched or with many innovations, central strand present; leaves

infolded, inflexed and appressed, twisted at the apex of the stem when dry, widely spreading when moist, long-spatulate, acute or obtuse, rarely emarginate; margin rarely somewhat lighter colored through 4-5 rows of thicker-walled cells, usually revolute in the middle; costa smooth or nearly so, brown, suddenly excurrent into a long, slightly toothed or smooth hyaline awn, consisting in cross section of 2 central guide cells, 2 large ventral cells, and a dorsal band of stereids whose outermost layer is undifferentiated; basal leaf cells smooth, rectangular, hyaline, those in the first marginal rows shorter and narrower, the upper cells thick-walled, densely papillose on both sides with several crescent-shaped papillae, quadrate, 10-18 μ in diameter. Monoicous. Seta 8-15 mm. long, reddish-yellow to red; capsule long-cylindric, erect, urn straight or somewhat curved, brown; calyptra reaching below the middle of the urn; operculum about one-third the length of the urn, narrowly conical, usually acute, cell rows spirally wound in several turns; cells of exothecium rectangular and longer, the long walls strongly thickened; annulus of 2 rows of cells, long persistent; tube of the peristome well-developed, pale, tessellate; peristome teeth wound in two or three complete turns; spores variable in size, from 10-18 μ , greenish-brown, papillose, ripening in spring. Type locality, Germany.

ILLUSTRATIONS:—Braithw. Brit. Moss-Fl. 1: *pl. 32F, figs. 1-10*; Bry. Eur. *pl. 164*; Dixon, Handb. Brit. Mosses (Ed. III) *pl. 25G*; Husnot, Musc. Gall. *pl. 33, figs. 1-10*; Jaeggli, Boll. Soc. Ticinese Sci. Nat. 1933: 11; Mönkemeyer, Laubm. Eur. *fig. 64f*; Roth, Eur. Laubm. *pl. 25, fig. 10a-d*; Schwaegr. Suppl. 2: *pl. 120, figs. 1-13*; Warnstorf, Kryptogamenfl. Mark Brandenb. 2: 279, *fig. 6a-c*; Wilson, Bryol. Brit. *pl. 43; Pl. 117*.

On the trunks of living trees, California and Nevada, north to Oregon and Washington; rare.

Plants of this species resemble to some extent small plants of *T. ruralis*, but are abundantly distinct in the corticolous habitat, the smooth or only faintly serrulate excurrent costa, and the leaf margin plane in the upper part. From *T. pagorum* this differs in the lack of propagula, although Limpricht (Die Laubmoose, 1: 680. 1888) describes vegetative propagation through brown, multicellular, long-cylindric propagula produced on the upper surface of the leaves.

16. *TORTULA LATIFOLIA* Bruch, Recens. Gen. Barbula. 38. 1823.

Syntrichia latifolia Hüb. Deutsch. Laubm. 342. 1833.

Barbula latifolia Bry. Eur. Mon. 41. 1842.

Tortula mutica Lindb. Musc. Scand. 20. 1879.

Plants in loose, fragile tufts, dirty to blackish-green; stems to 2-3 cm. high, usually about 1 cm., radiculose at the base, dichotomously branching; leaves lax, folded lengthwise, twisted and crisped when dry, wide-spreading when moist, the lower leaves distant, obovate, the upper leaves in a rosette-like cluster, 2-3 mm. long, about 1 mm. wide, spatulate, broadly rounded, often somewhat emarginate, rarely very short-apiculate or mucronate, but never with an awn; the margin usually reflexed in the lower half, plane or involute above, no differentiated border present; costa ending in the leaf apex, brownish, spinulose-papillose on the back, very strong, showing in section 2 median guide cells, usually 2 large ventral cells in 2 layers, and 3-5 rows of dorsal stereid cells; basal leaf cells hyaline even at the margins, rectangular to elongated, becoming shorter and very chlorophyllose above, rather conspicuously arranged in parallel rows, roundish-quadrate to hexagonal, isodiametric, about 10 μ in diameter, thin-walled, irregularly verruculose-papillose on both surfaces, the marginal row less strongly papillose. Dioicous. Seta 8-12 mm. long, yellow or pale above, red below; capsule erect, long-cylindric, urn 3 mm. long, straight or only slightly curved; calyptra covering a third of the urn; operculum to 1.5 mm. long, one-half the length of the urn, long-conic, acute, cells spirally twisted in about one complete turn; cells of the exothecium thin-walled, elongate-rectangular; annulus of 2-3 rows of cells, long-persistent; peristome pale, basal tube about 0.5 mm. high, peristome teeth wound in one or more complete turns; spores 10-12 μ , yellowish-brown, smooth, ripening in early spring. Vegetative propagation through small, green to brown, spherical, multicellular propagula produced in abundance over the upper surface of the leaf blade, becoming 25-35 μ in diameter. Type locality, Germany.

ILLUSTRATIONS:—Braithw. Brit. Moss-Fl. *pl. 32D, figs. 1-8*; Broth. Laubm. Fennosk. *fig. 29E-F*; Bry. Eur. *pl. 164*; Dixon, Handb. Brit. Mosses (Ed. III) *pl. 25F*; Husnot, Musc. Gall. *pl. 32, figs. 1-7*; Mönkemeyer, Laubm. Eur. *fig. 64d*; Roth, Eur. Laubm. *pl. 1, fig. 14, pl. 25, fig. 5a-c*; Warnstorf, Kryptogamenfl. Mark Brandenb. 2: 279, *fig. 8a-c*; Wilson, Bryol. Brit. *pl. 43; Pl. 117*.

EXSICCATI:—Sull. & Lesq. Musci Bor. Am. (Ed. II) 144.

On the base of trees, especially in wet places subject to inundation; known from California to British Columbia, but only from a few specimens.

The American specimens, although very similar to European specimens (Husnot's "Musci Galliae" No. 514, for example) differ in their smaller size and greener color, and the costa is only spinulose on the back, instead of being stellate-spinose. Furthermore, the seta is longer than in European material. Since the plants grow in moist places which may at times be flooded, the older parts of the plants, at least, are usually encrusted with mud. However, an inspection of the newest growth will show the characteristic round or truncate leaf apex and the still more characteristic spherical propagula produced directly on the surface of the leaf blade.

17. *TORTULA BARTRAMII* n. sp.

Plantae dense caespitosae, flavivirides vel fusciscentes; caulibus brevibus, 5-15 mm. longis; foliis appressis, superioribus si desiccatis paulum tortis, sed madidis erecto-patentibus, lingulatis vel spatulatis 1.5-2.0 mm. longis, apice acutiusculis vel obtusis; costa crassa, vix ad apicem versus angustata, dorso spinulosa, in aristam excurrentem crassam conspicue angustatam serratam 0.5-1.0 mm. longam basi solum rubescentem vel omnino hyalinam; cellulis basalibus magnis, rectangulis, hyalinis sursum, et versus margines parvioribus chlorophyllisque, superioribus isodiametricis, densissime verrucoso-papillois, obscuris, opacis. Dioicae ut videtur, sed archegoniatae solae visae. Sporogonium ignotum. A *T. pagorum* differt costa spinulosa, arista serrata et propagulis nullis. Specimen typicum ex loco "White House Canyon" dicto, montibus "Santa Rita," Santa Cruz Co., Arizona, in rupibus a E. B. Bartram (n. 794) lectum, 2 Feb., 1924, in herb. Univ. Mich.; dupla in herb. cl. Bartram et N. Y. Bot. Gard.

Plants densely caespitose in thin cushions, yellowish-green, dark green tinged with reddish-brown when dry; stems short, 5-15 mm. long, radiculose only at the base, sparsely dichotomously branched, with few innovations; leaves appressed, infolded lengthwise, and somewhat twisted at the apex of the stem when dry, erect-spreading and completely flat or slightly concave when moist, upper leaves larger and more crowded, lingulate to spatulate, 1.5-2.0 mm. long (not including excurrent costa), 0.6-0.8 mm. wide in the widest part, apex subacute to obtuse, rarely truncate; margin plane throughout or rarely slightly and narrowly revolute about half way up the leaf, the outermost cells not different in size, color, or thickness of wall, densely verrucose-papillose; costa thick, scarcely tapering, 80-100 μ wide from base to apex, reddish-brown, spinulose on the back, excurrent into a stout, conspicuously tapering, serrate awn 0.5-1.0 mm. long, hyaline throughout or red in the lower part, showing in cross section 2-4 very large guide cells, 2 ventral cells as large as the guides or 4 smaller ventral cells in 2 rows, and a thick dorsal band of 4-6 layers of stereids, the outermost layer undifferentiated except for somewhat thicker walls and the presence of spinulose papillae; cells of the basal quarter of the leaf on both sides of the costa large, hyaline, evenly rectangular, becoming smaller, shorter and chlorophyllose toward the margins and toward the apex, upper leaf cells somewhat seriate, 10-12 μ in diameter, roundish-quadrate to irregularly polygonal, isodiametric, very thick-walled, chlorophyllose and extremely densely verrucose-papillose, the leaf very obscure or opaque from a combination of the two factors. Apparently dioicous; archegonial plants common; perichaetial leaves undifferentiated; male plants not known. Sporophyte completely unknown. Type specimen from rock crevices, White House Canyon, at 6000 ft. altitude, Santa Rita Mountains, Santa Cruz County, Arizona, collected by E. B. Bartram, February 2, 1924, No. 794. (Type specimen in the Herbarium of the University of Michigan; cotypes in the Herbaria of the New York Botanical Garden and E. B. Bartram.)

ILLUSTRATIONS:—Pl. 115.

EXSICCATI:—Bartram, Mosses So. Arizona 794.

Mr. Bartram (*in litt.*) informs me that this species is very common in southern Arizona. I have seen many of his collections from rock faces and rock crevices in the Santa Rita, Patagonia, and Santa Catalina Mountains. The range is extended to New Mexico through several specimens collected by the late Bro. Arsène (distributed as *T. pagorum*), and to California through a single specimen.

It may be unwise to describe a new species from sterile material in as polymorphic and variable a genus as *Tortula*, but neither Mr. Bartram nor I can place this plant in any known North American species, and it seems to present consistently sufficient individuality in its vegetative character to separate it satisfactorily from all other species. The plants suggest *T. pagorum* in the very flat leaves with plane margins throughout, but differ in the costa spinulose-papillose on the back, and strongly toothed in the excurrent part. Furthermore, the upper leaf cells are much more densely papillose and obscure than in *T. pagorum*. *T. laevipila* is out of the question for the same reasons. The shorter awn and larger leaf cells distinguish it from *T. intermedia*. The plants in some ways resemble very poorly developed *T. ruralis* or *T. norvegica*, but the wide distribution of plants showing great constancy and agreement in morphology seems to preclude any possibility of a starved form of a larger species. Also, the completely plane leaf margins differ very strongly from the conspicuously revolute margins of *T. ruralis* and *T. norvegica*. This new species is most appropriately named after the man who not only collected the original material, but is also distinguished for his contributions to our knowledge of the American species of *Tortula*.

18. *TORTULA INTERMEDIA* Brid. in Berk. Handb. Brit. Mosses 251. 1863.

Syntrichia intermedia Brid. Bryol. Univ. 1: 586. 1826.

Barbula intermedia Milde, Bryol. Siles. 129. 1869.

Tortula montana Lindb. Musc. Scand. 20. 1879.

Barbula leptotricha C. Müll. & Kindb. in Macoun, Cat. Canad. Pl. 6: 60. 1892.

Plants in large, dark brownish- or reddish-green tufts; stems without a central strand, covered below with a loose, reddish-brown tomentum, 1–4 cm. high, branched; leaves crowded, erect-spreading with only the apex recurved when moist, appressed and infolded lengthwise but not much twisted when dry, oblong-spatulate, obtuse to emarginate at the apex, concave, 2–4 mm. long; margin widely revolute at the base, plane above; costa reddish-brown, rough on the back, abruptly excurrent into a long, hyaline, serrate awn, in cross section showing 2 median guides, 2 layers of large ventral cells, and a thick dorsal stereid band whose outer cells are not differentiated; upper leaf cells very densely papillose and chlorophyllose, nearly opaque, 9–10 μ in diameter, basal cells longer and hyaline, rectangular in the center and much narrower at the basal margins. Dioicous. Seta 1.0–1.5 cm. long, red; capsule erect, urn straight, short-cylindric, 2.5–3.0 mm. long, brown, operculum long-conic, about one-half the length of the urn, acute, its cell-rows only slightly twisted; annulus of 2–3 rows of cells, long persistent; peristome tube pale, about as long as the papillose teeth, which are usually twisted less than one full turn; spores 10–15 μ , brown, slightly papillose, ripening in spring. Type locality, France.

ILLUSTRATIONS:—Braithw. Brit. Moss-Fl. 1: pl. 33A, figs. 1–7; Dixon, Handb. Brit. Mosses (Ed. III) pl. 25H; Husnot, Musc. Gall. pl. 33, figs. 1–5; Limpr. Laubm. 1: fig. 188; Mönkemeyer, Laubm. Eur. fig. 65a; DeNot. Musci Ital. pl. 15, figs. 1–12; Roth, Eur. Laubm. pl. 17, fig. 18, pl. 25, figs. 8a–c; Pl. 118.

EXSICCATI:—Austin, Musci Appal. 132 (as *Barbula ruralis* var. *rupestris*); Macoun, Canad. Musci 226 (as *Barbula lateocisa*); Canad. Crypt. 66a (as *T. pulvinata*); Holz., Musci Acro. Bor. Am. 256 (as *Barbula laevipila*).

On calcareous rocks and soils, across northern North America, south to New Jersey in the east, where it is very rare, reaching California and Arizona in the west.

This species is most apt to be taken for an underdeveloped form of *T. ruralis*, from which it may be distinguished by the darker color, the spreading, but not squarrose leaves, the leaf margins plane above, the smaller leaf cells and the more emarginate leaf apex.

19. *TORTULA RURALIS* (Hedw.) Smith, Engl. Bot. 2070. 1808.

Barbula ruralis Hedw. Sp. Musc. 121. 1801.

Syntrichia ruralis Brid. in Schrad. Journ. 3²: 299. 1801.

Barbula laeviuscula Kindb. in Macoun, Cat. Canad. Pl. 6: 265. 1892.

Tortula laeviuscula Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 435. 1902.

Plants in loose tufts or mats which are often of wide extent, bright green above when moist, reddish- or golden-brown when dry; stems lacking a central strand, bearing a sparse reddish tomentum, especially at the leaf bases, dichotomously branching; leaves squarrose-recurved from a somewhat sheathing base when moist, loosely appressed, plicate and somewhat twisted when dry, especially at the apex of the stem, long oblong-spatulate, 3–7 mm. long, including the awn, blunt, truncate, or rarely emarginate at the apex; sharply carinate; margin revolute to or nearly to the apex; costa red or brown, sharply and densely spinose-papillose on the back, excurrent into a long, sharply-serrated awn (1–3 mm. long) which may be hyaline throughout or reddish at the base; in cross section showing 2 central guide cells, a double layer of large ventral cells, and a thick dorsal band of stereid cells, of which the outermost row is not differentiated; upper leaf cells green, densely verrucose- or rarely stellate-papillose, often nearly opaque, 12–16 μ , at the base of the leaf becoming much larger, longer and hyaline, except at the margins where the shorter, narrower cells are yellowish or greenish. Dioicous. Seta 1–3 cm. long, red; the capsule erect, long-cylindric, urn straight or very slightly curved, 3–5 mm. long, brown; operculum long and narrowly conic, about half the length of the urn, rarely somewhat oblique; annulus of 1–3 rows of cells, persistent, at least in part; basal tube of the peristome a pale, dusty red, obliquely tessellate, nearly or quite as long as the red, papillose peristome teeth, which are twisted at least two full turns; spores 10–14 μ in diameter, brownish, slightly granulose, ripening in spring. Type locality, Germany.

ILLUSTRATIONS:—Braithw. Brit. Moss-Fl. 1: pl. 33B, figs. 1–7; Bry. Eur. pl. 166; Dixon, Handb. Brit. Mosses (Ed. III) pl. 26A; Grout, Mosses with Hand-Lens (Ed. III) pl. 35; Hedw. Fund. Hist. Nat. Musc.

Frond. 1: *pl. 6, figs. 29-32*; Hook. & Tayl. Musc. Brit. *pl. 12*; Husnot, Musc. Gall. *pl. 33, figs. 1-8*; Mönkemeyer, Laubm. Eur. *fig. 64g*; DeNot. Musci Ital. *pl. 14, figs. 1-13*; Roth, Eur. Laubm. *pl. 17, fig. 17, pl. 25, fig. 7a-c*; Schwaegr. Suppl. 1: *pl. 34, figs. 1-4*; Sim, Bryoph. So. Africa, p. 226; Smith, English Bot., *pl. 2070*; Warnstorf, Kryptogamenfl. Mark Brandenb. 2: 279, *fig. 3a-c*; Wilson, Bryol. Brit. *pl. 12*; M. H. M. *pl. 35*.

EXSICCATI:—Drumm. Musci Am. 143; Austin, Musci Appal. 131 (as *Barbula*); Sull. & Lesq. Musci Bor. Am. (Ed. I) 100, (Ed. II) 145, 146 (as *Barbula*); Ren. & Card. Musci Am. Sept. 165; Macoun, Canad. Mosses 63a; 67a (as *T. pseud-aciphylla*); 68a (as *T. laeviuscula*); 82 (as *T. submegalocarpa*); 502 (as *Barbula pseudo-aciphylla*); Canad. Musci 79, 606 (as *Barbula megalocarpa*); 83 (in part, as *Barbula Muelleri*); Canad. Crypt. 23 (as *Barbula alpina*), 24 (as *Barbula papillinervis*), 25 (as *Barbula laeviuscula*), 123 (as *Barbula*); Holz. Mosses of Colo. 13 (as *Barbula Muelleri*), Mosses of Minnesota 13 (as *Barbula*), Musci Acro. Bor. Am. 180, 181, 181b; 234 (as *T. aciphylla*), 425 (as *T. montana*), 575 (as *T. princeps*); Allen, Mosses of Cascade Mts. 20; Univ. of Wyoming, Plants of Ariz. 2129; Bartram, Mosses of N. Mex. 55, Mosses of So. Ariz. 7; Grout, Musci Perf. 104, 306.

Growing on soil and rocks of many types, although usually calcareous. This is our most ubiquitous and variable species, and is widespread through all of Canada, much of the United States, and well into Mexico.

Although extremely variable in size, as a reflection of its tolerance for different environmental conditions, this species may usually be recognized by the obtuse leaves which are deeply carinate, even when moist, and then squarrose-recurved, the leaf margins revolute from base to apex, the extremely hispid excurrent costa, and the unfailingly dioicous inflorescence.

20. TORTULA RURALIFORMIS (Besch.) Dixon, Handb. Brit. Mosses. 188. 1896.

Barbula ruraliformis Besch. Bull. Soc. Bot. Fr. 11: 334. 1864.

Tortula ruralis (Hedw.) Smith var. *arenicola* Braithw. Brit. Moss-Fl. 1: 226. 1885.

Plants in deep, dense tufts, yellowish- or reddish-brown, more rarely green above, reddish below; stems without central strand, branching rather freely, 2-8 cm. long; leaves very strongly squarrose-recurved when moist, appressed when dry, ovate-lanceolate to oblong, narrowed gradually into an acute, hyaline, dentate point which runs into and joins the awn; margin revolute nearly to the apex; costa reddish, excurrent into a very rough awn confluent with the hyaline, toothed uppermost part of the lamina; green cells of upper lamina as in *T. ruralis* or somewhat smaller, basal areolation as in *T. ruralis*. Dioicous. Sporophyte as in *T. ruralis*. Type locality, France.

ILLUSTRATIONS:—Dixon, Handb. Brit. Mosses (Ed. III) *pl. 26B*; Husnot, Musc. Gall. *pl. 33, figs. 1-2*; Mönkemeyer, Laubm. Eur. *fig. 65d; pl. 116*.

EXSICCATI:—Canad. Musci 79 (in part, as *Barbula megalocarpa*).

Although in Europe this species grows characteristically in sand, and is often nearly buried in it, I have seen no American specimens from sand, but only from a soil or rock substratum. Widespread from northern California to British Columbia on the Pacific Slope, east to Colorado, Wyoming and Montana.

This moss, when well developed, is very characteristic, of about the same size and with much the same habit as *T. ruralis*, the leaves of some specimens even more squarrose-recurved. The leaves are different in shape, however, tapering gradually to an acute, hyaline, dentate or serrate point which runs into and joins the excurrent costa. The confluence of the hyaline leaf margin and hyaline costa reminds one strongly of the similar condition characteristic of some species of *Racomitrium*, for example *R. lanuginosum*. As intermediate forms linking this with *T. ruralis* commonly occur, *T. ruraliformis* is considered by some bryologists as a variety of it. Dixon considers it to be of only subspecific rank, and I agree that if it is recognized as a species at all, it is a "small" species close to *T. ruralis*.

21. TORTULA NORVEGICA (Web. & Mohr) Wahlenb. in Lindb. de Tort. 245. 1864.

Barbula norvegica Lindb. Öfvers. Vet.-Akad. Förh. 20: 387. 1863.

B. aciphylla Bry. Eur. Mon. 42. 1842.

Tortula aciphylla Hartm. Skand. Fl. (Ed. V) 381. 1849.

Barbula brachyangia C. Müll. & Kindb. in Macoun, Cat. Canad. Pl. 6: 59. 1892.

Tortula brachyangia Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 435. 1902.

Barbula rufipila Card. & Thér. Bot. Gaz. 30: 123. 1900.

Tortula rufipilis Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 435. 1902.

Plants in dense tufts, green above, reddish-brown below; stems without central strand, loosely tomentose, 2-10 cm. long, branching dichotomously and through innovations; leaves squarrose-recurved from an appressed base, especially at the apex of the stem when moist, appressed, infolded, and slightly twisted when dry, oblong-elliptical to ovate-lanceolate, more or less acute; margin narrowly revolute from the base to or

slightly above the middle; costa brownish-red, spinose to verruculose-papillose on the back, excurrent into a long, reddish awn, which varies from nearly smooth to serrate, but usually less rough than in *T. ruralis*. Upper leaf cells as in *T. ruralis*, nearly all the basal cells hyaline, without a differentiated margin, becoming darker with age. Dioicous. Seta 1-2 cm. long, capsule erect, short-cylindric, the urn about 3 mm. long, straight, operculum long and narrowly conic, acute, more than half the length of the urn; annulus of 2-3 rows of cells, persistent, at least in part; basal tube of the peristome pale, nearly as long as the yellowish-red, papillose, much twisted teeth; spores 10-15 μ in diameter, smooth, ripening in summer. Type locality, Europe.

ILLUSTRATIONS:—Broth. Laubm. Fennosk. fig. 29A-D; Bry. Eur. pl. 165; Dixon, Handb. Brit. Mosses (Ed. III) pl. 26D; Husnot, Musc. Gall. pl. 33, figs. 1-3; Mönkemeyer, Laubm. Eur. fig. 65c; DeNot. Musci Ital. pl. 16, figs. 1-12; Roth, Eur. Laubm. pl. 25, fig. 6a-c; Pl. 116.

EXSICCATI:—Macoun, Canad. Musci 82 (as *Barbula ruralis*), 221 (as *Barbula*), 222a (as *Barbula pseud-aciphylla*), 479 (as *Barbula aciphylla*), Canad. Mosses 64a (as *T. papillinervis*), 65a.

An arctic and alpine species; on rocks and thin soil covering rocks from Greenland, across the American Arctic Archipelago, to Alaska, south in the Rocky Mountains into the western United States.

This moss, although intergrading to some extent with *T. ruralis*, and considered by some to be only a variety of it, is not difficult to distinguish, through the much less revolute upper leaf margins, the red, smoother excurrent costa, and the restricted range.

22. TORTULA OBTUSISSIMA (C. Müll.) Mitt. Journ. Linn. Soc., 12: 174. 1869.

Barbula obtusissima C. Müll. Syn. Musc. 1: 640. 1849.

Plants densely caespitose, bright glaucous green, rarely brownish or reddish, appearing hoary from the long hyaline leaf awns which all lie parallel in curious brushes or tufts in dry plants; stems without a central strand, loosely tomentose, short, to 2 cm., branching dichotomous; leaves appressed, sharply carinate and plicate when dry, closely twisted around the apex of the stem in a very characteristic manner when dry, widely spreading but not squarrose when moist, often showing clearly an arrangement in spiral rows, oblong to obovate, deeply concave, somewhat cucullate, the borders of the widely inflexed upper leaf margins sometimes touching, making the leaf tubular, even when moist, very obtuse, emarginate or retuse at the apex, the blade 3-4 mm. long; margin narrowly revolute nearly to the apex, not bordered in any way; costa red, thick, suddenly excurrent into a hyaline, extremely serrate and spinose roughened awn usually longer than the leaf itself, 3.5-5.0 mm. long, in cross section showing 2-4 very large median guide cells, 1 or 2 rows of large ventral cells, and a massive dorsal band of stereids whose outer layer is not differentiated, except for papillae; upper leaf cells larger than in *T. ruralis*, 16-24 μ in diameter, mamillate and densely spinose- and verrucose-papillose; thin-walled, basal cells much larger, hyaline, narrow at the margins. Dioicous. Seta short, stout, red, 10-14 mm. long; capsule erect, the urn straight or curved, long-cylindric, tapering to the mouth, about 3 mm. long; operculum long-conic, to 2 mm. long; peristome as in *T. ruralis*. Type locality, Mexico.

ILLUSTRATIONS:—Pl. 115.

Mr. Bartram, in reporting this species for the first time from our range, from Texas, says (Bryologist 32: 8): "The robust habit, widely spreading (not squarrose-recurved) leaves when moist, emarginate apex and large verrucose-papillose upper leaf cells are characters which, in the aggregate, distinguish this plant from the ubiquitous *T. ruralis*. This collection agrees in every essential particular with specimens from Mexico and is of uncommon interest as representing the first record for the species in the United States." In running over a large series of specimens from several herbaria, I have recognized about a dozen additional collections, labelled "*T. ruralis*" or "*T. intermedia*," which extend the known range in the United States to Arizona (Leiberg 1062), Nevada (Griffiths & Morris 44), and California (Bolander 82; Howe, Musci Calif. 7).

23. TORTULA PRINCEPS DeNot. Syll. Musc. Ital. 170. 1838.

Barbula Muellieri Bruch, Bryol. Eur. Mon. 44. 1842.

B. princeps C. Müll. Syn. Musc. 1: 636. 1849.

Tortula Muellieri Wils. Bryol. Brit. 134. 1855.

Syntrichia princeps Mitt. Journ. Linn. Soc., Bot. 1 (suppl.): 39. 1859.

Plants in dense, wide tufts or mats, greenish- to brownish-red; stems without central strand, with an abundant reddish tomentum, especially in the leaf axils, 2-10 cm. high, branching dichotomously and by innovations; leaves crowded and larger at the apex of the stem, typically in interrupted or verticillate

rosulate tufts along the stem, erect-spreading, reflexed only at the apex when moist, appressed, slightly infolded and little twisted when dry, even at the apex of the stem; upper, larger leaves 2–5 mm. long, broadly lingulate or spatulate, concave, obtusely acute, rounded, or rarely emarginate at the apex; margin narrowly revolute in the lower half or two-thirds of the leaf; costa thick, very rough on the back, red, abruptly excurrent into a long, usually hyaline, serrate awn, in cross section showing 2 median guides, 2–3 layers of ventral cells, and a thick dorsal stereid band whose outermost cells are not differentiated; upper leaf cells green, densely papillose, quadrate, 12–14 μ in diameter, the basal cells rectangular, hyaline or somewhat reddish. Polygamous or synoicous. Seta 1–3 cm. long, red; capsule erect, cylindric, urn straight or somewhat curved, to 6 mm. long, reddish-brown, becoming darker and irregularly striate when old; operculum long-conic, about half as long as the urn, its cell rows twisted several times; annulus of 1–3 rows, persistent; basal tube of the peristome pale reddish, becoming pure white when old, obliquely tessellate, as long as the papillose teeth, which are twisted about two full turns; spores 10–15 μ in diameter, yellowish-green, smooth, ripening in spring. Type locality, Sardinia.

ILLUSTRATIONS:—Bartram, Hawaiian Mosses, fig. 64; Braithw. Brit. Moss-Fl. 1: pl. 33C, figs. 1–7; Bryol. Eur. pl. 168; Dixon, Handb. Brit. Mosses (Ed. III) pl. 26E; Husnot, Musc. Gall. pl. 34, figs. 1–9; Mönkemeyer, Laubm. Eur. fig. 65e; DeNot. Musci Ital. pl. 13, fig. 1–16; Roth, Eur. Laubm. pl. 25, fig. 1a–d; Sim, Bryophytes of So. Africa, p. 226; Wilson, Bryol. Brit. pl. 44; Pl. 116.

EXSICCATI:—Sull. & Lesq. Musci Bor. Am. (Ed. I) 100b, (Ed. II) 147 (as *Barbula*); Lesq. Calif. Mosses 147; Ren. & Card. Musci Am. Sept. 26 (as *Barbula*); Baker, Pacific Slope Bryoph. 682 (as *Barbula ruralis*), Suppl. Plants Pacific Coast 3644; Heller, Plants of Calif. 7259, 7252, 5204 (as *Barbula*), 7244 (as *Barbula laevipila*); Allen, Mosses of Cascade Mts. 21; Macoun, Canad. Musci, 80, 83 (in part), 230 (as *Barbula*), 74 (as *Barbula laevipila*), 223 (as *Barbula megalocarpa*), 221 (as *Barbula norvegica*), Canad. Mosses 81 (as *T. megalocarpa*), 443 (as *Barbula*), Canad. Crypt. 23 (as *Barbula alpina*), Flora Canad. 2096 (as *Barbula*); Holz. Mosses of Colo. 13; Musci Acro. Bor. Am. 234 (as *T. aciphylla*), 449, 650; Grout, Musci Perf. 267.

On soil and rocks, apparently both common and abundant on the Pacific Slope from Mexico to southern Alaska, extending eastward in the Rocky Mountains to Idaho (Leiberg 145) but not nearly as common there as the many reports, based on erroneous identifications, might indicate.

This species is very distinct from *T. ruralis*, yet is very commonly confused with it. The leaves are disposed in interrupted, verticillate whorls along the stem, nearly plane when dry, not infolded lengthwise, and spreading when moist, never squarrose-recurved. The leaf margin is not quite so revolute as in *T. ruralis*, although this is not a very clear cut distinction in our range. The most final and convincing feature of *T. princeps* for identification is the presence on nearly all fertile plants of the characteristic synoicous inflorescence. Even when the antheridia have weathered away and disappear completely, the bundle of paraphyses usually persists. However, the antheridia are apparently produced continuously for two whole seasons in some plants; at least I have often found mature antheridia which have not yet opened, as well as more immature stages at the base of one year old sporophytes. As some of the "flowers" contain only archegonia, and are apt to give a false impression of a dioicous plant, it is wise to examine several "flowers" before calling the plant *T. ruralis*, which is very rare on the Pacific slope, being replaced in large part by the present species.

EXCLUDED SPECIES

The following species, although well known and of wide distribution in Europe, do not seem to be members of the North American flora, as all reports of them in our range are apparently based on misidentifications: *Tortula alpina* (Bry. eur.) Bruch, *Tortula canescens* (Bruch) Mont., *Tortula cuneifolia* (Dicks.) Roth, *Tortula laevipilaeformis* DeNot., *Tortula marginata* (Bry. eur.) Spruce, and *Tortula Vahlana* (Schultz) DeNot.

The following are rejected for the reasons given:

1. *Tortula astoriensis* Broth. in Röhl, Abh. d. Naturw. Ver. Bremen 14: 193. 1897. I can find no description for this name, the type specimen cannot be found in Brotherus' Herbarium (*vide* Dr. Harald Lindberg, *in litt.*), and Brotherus does not include it in either edition of his Musci in Engler & Prantl. It is apparently a *nomen nudum*.

2. *Barbula carnifolia* C. Müll. & Kindb. in Macoun, Cat. Canad. Pl. 6: 52. 1892. The original material of this species cannot be found either at Stockholm or at Ottawa, and Kindberg himself soon abandoned the name. Consequently, it must be rejected as a *nomen dubium*.

3. *Tortula Egelingii* (Schlieph.) Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 430. 1902. A small fragment of the type specimen, which agrees well with the original description, has been seen. It is certainly *Desmatodon Porteri* James.

4. *Barbula latoexcisa* C. Müll. & Kindb. in Macoun, Cat. Canad. Pl. 6: 60. 1892. Most of the original material of this species, which Kindberg later placed in synonymy under *Tortula pulvinata* Jur., seems to be *T. princeps*.

5. *Barbula papillinervis* C. Müll. & Kindb. in Macoun, Cat. Canad. Pl. 6: 60. Although Kindberg later considered this to be a subspecies of *Tortula pulvinata*, none of the various specimens cited in the original description are that species, which apparently does not occur in our range. Since the different collections upon which the species was based actually represent several different species, including *Barbula cylindrica*, *Tortula ruralis*, *T. norvegica*, and *T. intermedia*, the name should be rejected as a *nomen dubium*.

6. *Tortula pseudoaciphylla* (Kindb.) Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 435. 1902. The history of this species is so complex, and so many different species are involved in the supposed type material that the name should be rejected. The species was based on two of Röhl's specimens which had been previously identified as *T. intermedia*, yet the Canadian specimens identified by Kindberg as *T. pseudoaciphylla* are a series of several species, none of them *T. intermedia*!

7. *Tortula rotundoemarginata* (C. Müll. & Kindb.) Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 435. 1902. Most of the specimens so-named, both in Kindberg's Herbarium and in Macoun's Herbarium, are actually *T. intermedia*.

8. *Tortula submegalarcarpa* (Kindb.) Broth. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 435. 1902. Since the specimens so-identified by Kindberg are in large part *T. ruralis* and *T. princeps*, but also include other species, the name should be rejected as a *nomen dubium*.

11. MERCEYA Schimp. Syn. (Ed. 2). 852. 1876.

Scopelophila Spruce, Jour. Bot. No. 217. 1881.

Plants in loose or dense tufts; stems branched, erect, 1–5 cm. high, obscurely 5-angled, without central strand; leaves oblong to ligulate, obtuse or bluntly pointed, costa ending below the apex; margin bordered by 3–7 rows of thickened and enlarged cells which are frequently colored; upper median leaf cells quadrate to oblong, faintly papillose or apparently smooth, basal cells becoming enlarged, oblong, usually thin-walled or inflated. In cross section the costa shows 1–2 rows of enlarged thin-walled cells on the ventral (upper) side, the main portion within is a sterile tissue bordered on the dorsal side by cells slightly larger and less thickened; in section the thickened leaf margin is clavate in outline, the cells thick-walled and often colored; dioicous; perigonium terminal, orange-yellow, paraphyses numerous; fruit unknown.

The systematic position of this genus is not well established since the sporophyte has never been observed. The structure of the stem and leaves relates it to both *Tortulaceae* and *Encalyptaceae*, and it has been placed in each of these families by various authors.

KEY.

- | | |
|---|-----------------------|
| Plants small, slender; leaves 2–3 mm. long, erect to patent; upper leaf cells mostly quadrate 10–15 μ in diameter. | 1. <i>ligulata</i> . |
| Plants large, robust; leaves 3–5 mm. long, patent to spreading; upper leaf cells mostly hexagonal, 18–26 μ in diameter. | 2. <i>latifolia</i> . |

I. MERCEYA LIGULATA (Spruce) Schimp. l. c.

Encalypta ? *ligulata* Spruce, Musci Pyren. No. 331. 1845; Trans. Bot. Soc. 3^d: 187. 1850.

Zygodon ligulatus C. Müll. Syn. 2: 636. 1851.

Weisia ligulata Mitt. Jour. Linn. Soc. 12: 135. 1869.

Scopelophila ligulata Spruce, Jour. Bot. New Series. 10: 12. 1881.

Plants in compact tufts up to 4 cm. or more high; stems slender, branched, green at the tips, reddish or dark brown below, radiculose; leaves ligulate to oblong, spatulate, 1–1.5 mm. long, broadest near the apex, base oblong and narrowed, apex bluntly pointed or obtuse, somewhat concave to keeled, occasionally mucronate, comal leaves acute or obtuse, costa ending below the tip or nearly percurrent, in cross section semilunar, mostly slender, prominent at the back (weak in North American plants) with a single row of large ventral cells; margins entire, plane or slightly recurved below, thickened in older leaves; median upper cells quadrate to oblong or irregular, 10–15 μ , apparently smooth or with low convex papillae, marginal cells frequently transversely elongated and in some older leaves marginal cells enlarged, thick-walled; basal cells larger, up to 18 x 45 μ , oblong, usually thin-walled or inflated, marginal row narrower, linear, thicker-walled, in older leaves the basal cells are frequently thick-walled. Dioicous. Perigonium terminal; sterile except a few shrunken archegonia. Type locality European.

ILLUSTRATIONS:—Husnot, *Musc. Gall. pl. 79*; Limpr. *Laubm. 2: 124. f. 249; Pl. 120.*

EXSICCATI:—Sharp, 34287; and Bryophytes of Eastern U. S. 183; Grout, *Musci Perf. 256.*

A rare plant in North America. A. J. Sharp collected it on moist shaded rocks in the Great Smoky Mountains of Tennessee. The plant compares very favorably with European specimens. The costa is not as stout nor as prominent at the back as Limpricht shows. The thickened border is not evident in the upper green leaves but in the older colored leaves the marginal cells become thickened and in cross section the lamina is clavate at the margin. The cells of the extreme outer margin are smaller.

1a. Var. *BARTRAMII* E. Bauer, *Musci Eur. & Am. 1834. 1925.*

Differs from the species in the more slender and lax habit, the leaves narrower, the lower half or two-thirds of enlarged lax cells, the costa very weak, not prominent at the back. Upper medial cells 7–8 μ , quadrate to oblong; basal cells very large, up to $22 \times 55 \mu$, thin-walled and often inflated. Type locality, Flux Canyon, Patagonia Mountains, Santa Cruz Co., Arizona.

ILLUSTRATIONS:—*Pl. 120.*

EXSICCATI:—Holzinger, *Musci Acro. Bor. Am. 546*; Bartr. *Mosses of S. Arizona 124*; E. Bauer, *Musci Eur. & Am. 1834.*

E. B. Bartram collected this variety on ledges in a stream bed. It seems to be like other members of the genus with respect to habitat.

2. *MERCEYA LATIFOLIA* Kindb. *Bull. Torr. Club 16: 94. 1889*; Macoun *Cat. Can. Pl. 6: 97. 1892.*

Plants in loose or dense tufts, rather coarse, dark green, often tinged with red. Stems branched, 2–5 cm. high, radiculose and reddish below, naked or with older leaf bases and costae adhering, apex of branches with a tuft of green leaves, usually tinged with reddish or orange color and frequently encrusted with mineral deposit; leaves slightly crisped or curved when dry, not greatly altered, patent to spreading when moist, often forming a terminal rosette, broadly spatulate or ligulate, a few oblong, 3.5–5 mm. long, base narrower, gradually increasing in width upward, apex broad and rounded, tip with a short mucro which may be blunt or pointed; costa stout, prominent at the back, percurrent or forming the mucro, yellowish or reddish, in cross section semilunate with two rows of thin-walled ventral (upper) cells and a large area of central stereids, dorsal cells of a single layer, thin-walled or often rather thick and not strongly differentiated from the small stereids; margins bordered with 3–7 rows of orange-colored, thick-walled and enlarged cells, slightly recurved, revolute at the base; upper median cells quadrate to oblong or hexagonal, 18–26 μ wide and up to 38 μ long, marginal cells enlarged, thick-walled, rounded, oval or oblong, the extreme marginal row very much smaller, 6–8 μ wide, in cross section the lamina is clavate in outline at the margin; basal cells becoming larger, oblong 18–30 μ wide and up to 95 μ long, thin-walled, often inflated, marginal ones narrower, linear, walls thicker, often colored; papillae evident on the upper cells, usually low and simple, occasionally rather strong. Dioicous. Flowers not seen, fruit unknown. Type locality in British Columbia (Vancouver Id., May 18, 1887, probably the type collection).

ILLUSTRATIONS:—Williams, *Bull. N. Y. Bot. Gard. 2: pl. 37; Pl. 120.*

EXSICCATI:—Flowers, *Mosses of Utah 26*; Macoun, *Can. Musci 459.*

On damp soil and rock, especially bordering streams and sometimes submerged in the swift current. British Columbia, California, Utah, Colorado and Montana.

This plant is rather rare but plentiful in local regions. It is abundant in certain canyons in Utah where Dr. Flowers has seen it growing in dense masses along dashing streams and even submerged in the swift current. It was noted that plants growing on the wet rocks away from the spray exhibit the orange-colored border on the leaves more strongly than is the case in plants growing in the spray, while in plants growing in the water it is usually lacking. Also, the submerged plants are brighter green and the stems are not as naked as in aerial forms. Just how the plant multiplies is not definitely known but in the course of examining specimens a structure was observed which strongly resembled a bulbil. Being detached and a similar structure not being observed in actual position on the plant, the validity of the observation is questionable. Certain rhizoids approach the form of brood bodies, but in no case were any seen which could be definitely associated with such structures.* The leaf cells average twice as large as in *M. ligulata* and smooth or slightly papillose on the more conspicuous border cells.

* Acknowledgments are made to Dr. Flowers for collaboration in the preparation of the manuscript on *Merceya*.

12. BRYOBRIITTONIA Williams, Bull. N. Y. Bot. Gard. 2^o: 115. 1901.

Plants with costal structure like the Pottiaeae, and mamilllose cells much like the upper layer of cells in *Timmia*, but unistratose and mamilllose on both faces. The soft texture of the leaves and the paraphysis-like hairs in the leaf axils suggest the *Splachnaceae*. Its true relationships will remain obscure until capsules are found.

BRYOBRIITTONIA PELLUCIDA Williams, l. c.

Stems mostly simple, in loose tufts up to 2 cm. high; central strand present, distinct, of numerous small thin-walled cells; comal leaves much the largest, often inclosing numerous long paraphysis-like hairs, oblong-lanceolate to subspatulate, widest above the middle, up to 7.5 x 1.5 mm., more or less shriveled and contorted when dry, obtuse to obtusely acute; margins plane, crenulate-serrate above by projecting cell angles; costa strong, ending several cells below the apex, in cross section with median guides and 2-3 rows of cells nearly as large on the ventral side and a dorsal stereid band bordered on the dorsal surface by a row of slightly larger cells; upper leaf cells rhomboidal to hexagonal, 15-20 μ in longest dimension, strongly mamilllose on both faces; basal cells smooth, elongate rectangular, those near the costa up to 20-30 x 100 μ or more, those at the margins narrower, 4-6 mm. wide and running up the margin beyond the area of short mamilllose cells. Antheridia and archegonia unknown. Type locality, Yukon River just below Dawson on rock, April 6, 1899, no. 587 (Williams). Type examined.

ILLUSTRATIONS:—Williams, l. c. *pl. 16; Pl. 109.*

The above description adapted from the original by Williams.

CINCLIDOTUS FONTINALOIDES (Hedw.) P. B.

This species was reported from Ontario by Macoun in the Lesq. & James Manual p. 134, but no North American specimens can be found at The Canadian National Museum at Ottawa, at the U. S. National Museum, The New York Botanical Garden or at the Farlow Herbarium of Harvard. It seems pretty certain that Macoun's record was due to an error in determination.

ADDITIONS AND CORRECTIONS

FISSIDENS MINUTULUS f. AUSTRALIS n. f.

Cellulae foliorum 7-8 μ ; margine laminae dorsalis in parte inferiore evanido.

Leaf cells mostly obscure, bulging, mostly 7-8 μ in diameter; border narrow, often vanishing on the lower $\frac{1}{2}$ of the dorsal lamina. N. Carolina (Anderson, no. 2691; Bevan, 466 & 611; Georgia, Small, 9137).

FISSIDENS RADICANS Mont. Ann. Soc. Nat. Ser. 2, 14: 345. 1840.

Fissidens flavicans Schimp. in Herb. Kew (according to Salmon, Ann. Bot. 13: 125. 1899).

Fissidens Smallii E. G. Britton in Herb. N. Y. Bot. Garden.

Close to *F. Donnellii*, distinguished as follows:—The plants are a little larger as a rule, more often branching by innovations; the leaves narrowly oblong and of nearly uniform width until near the obtuse apex; leaf cells more regular, smaller, rarely over 8 μ , less angular, mamilllose-bulging rather than papillose; marginal cells smaller and less acute, not more strongly crenulate on the vaginant laminae than near the apex. Sporophyte terminal or occasionally on a short lateral branch. Type locality, French Guiana. *Pl. 122.*

My attention was called to this species by Mr. Bartram, who sent me a specimen from Royal Palm Park, Florida, collected by Small and others (no. 7191, which Mrs. Britton had called as an herbarium name, *F. Smallii*). This is the same as the specimen from Coconut Grove mentioned on p. 18 of this volume. It has also been collected at Deering Hammock near Miami by Mrs. Britton and in Costello Hammock, Dade Co., Fla. by McFarlin; Manatee, Fla. (Groul). It is found on rotten wood and limestone southwards to Brazil. Mr. Bartram is responsible for identifying the Florida moss with *F. radicans*. The illustrations of the leaves of *F. Donnellii* (*Pl. 10*) show leaves almost exactly the outline of *F. radicans*. Most of the leaves of *F. Donnellii* are gradually narrowed above and acute, as Mrs. Britton describes them. In *F. radicans* the leaves are of a nearly uniform width until they are usually abruptly "pinched" off to the narrower obtuse apex. However, the much more coarsely toothed vaginant laminae of *F. Donnellii*, especially on the perichaetial leaves, is well shown in *Pl. 10, f. 6*.

FISSIDENS LITTLEI (Williams) **n. comb.**

Moenkemeyera Littlei Williams, Bryol. 39: 40. pl. 4. Sept. 30, 1936.

Fissidens Orcuttii Grout, Moss Fl. N. Am. 1: 20. Oct. 23, 1936. (Which see.)

Peristome teeth undivided, from a short basal membrane, warty-papillose; spores about $8\ \mu$, mature in spring. Type locality, vertical shaded walls of gypsum sink, two to four feet below the general surface of gypsum deposits a mile or so north of Middle Well, alt. 4200 ft., New Mexico (*E. L. Little*, no. 108, June 9, 1935).

Specimens from the type locality have been studied through the courtesy of Mr. Little.

The only distinction between *Fissidens* and *Moenkemeyera* is the undivided teeth of the latter. Undivided teeth are found in the subgenus *Otodiceras* (*F. Hallianus*), and in the section *Sublimbati*, and in this species with wholly unbordered leaves. Thus the undivided peristome teeth occur in such varied parts of the genus that it seems better to leave such species in *Fissidens*, rather than erect a parallel. *Littlei* will key out to *Orcuttii* in the key, Vol. 1, p. 8.

FISSIDENS NEONI (Bartr.) **n. comb.**

Moenkemeyera Neoni Bartr. Bryol. 34: 77. 1931.

Plants minute, dull yellowish green, closely gregarious, radiculose at base, male and female plants matted together; stems of fruiting plants about 1 mm. high, imbedded in the soil, bearing 3-4 pairs of leaves; lower leaves very small, with vaginant laminae only; upper leaves abruptly larger, ovate to broadly lanceolate, 0.6-0.8 mm. long; vaginant laminae extending about $\frac{1}{2}$ the way to the apex; dorsal lamina ending about half way down in the broader leaves, in some of the narrower leaves reaching nearly to the insertion; perichaetial pair of leaves larger, reaching 1 mm. in length; margins slightly crenulate; costa percurrent or ending just below the apex; leaf cells rhomboidal and hexagonal, 8-10 μ in diameter, smooth; margins of the vaginant laminae and frequently median margin of dorsal lamina bordered by narrowly linear cells; apical margins not bordered; sterile stems simple or branched, 3-4 mm. long, with leaves 0.8 mm. wide, bearing 10-20 pairs of leaves, which are oblong-ovate, 0.5 mm. long with border usually distinct on the vaginant laminae. Dioicous; male plant bearing a few antheridia enclosed by 3-4 laxly areolate concave perigonal leaves, which are broadly notched at the apex of the vaginant laminae; seta terminal, reddish, 2.5-3 mm. long; capsule erect, oblong-cylindric, up to 1.5 mm. long by 0.5 mm. broad, contracted under the mouth when dry; peristome teeth 16, not divided, erect-spreading when dry, strongly incurved when moist, nearly smooth below, papillose in the upper part, not striate, fragile; operculum conic-rostrate, erect; calyptra very small and fugacious; spores minutely papillose, 20-25 μ in diameter. Type locality, vicinity of Lafayette, Louisiana, March 30, 1931 (Bro. *Néon*, no. 885).

Description adapted from the original. This species will key out to *F. Ravenelii* in the key on p. 9 from which it is distinguished by its smooth leaves and undivided peristome teeth.

ILLUSTRATIONS:—Bryol. l. c. pl. 5; Pl. 121B.

CAMPYLOPUS CAROLINAE **n. sp.**

Plantae minimae, 1-2 cm. altae; folia inferiora minora; folia superiora 4-6 mm. longa, maxime varia, ad basin ovata vel oblanceolata, ad apicem lineare-lanceolata serrataque; costa longe excurrente, saepe perlicuda in parte superiore.

Plants small, mostly under 2 cm., lower leaves smaller and more appressed, the comal longer and more spreading when dry, reaching 6 mm. or more in length, as a whole most variable even on the same plant, very concave, subtubular above, some narrowly lanceolate and evenly narrowed to the slender toothed awn, with costa nearly $\frac{1}{3}$ the width at the base, and alar cells inflated forming auricles, others lance-subulate from an oblong-ovate base with costa only $\frac{1}{7}$ - $\frac{1}{8}$ the width of the leaf at base and alar cells not inflated or differentiated; basal cells long-rectangular about 15×45 - $75\ \mu$, hyaline, gradually changing upwards to the cells of upper base, which are mostly rounded and oblong, rectangular, or rhomboidal, 2-3 : 1, in the narrower lamina above 2-4 : 1 and flexuose; costa long-excurrent into a slender toothed awn which may be $\frac{1}{3}$ the length of the leaf and often decolored and hyaline in the upper portion, in cross section with a central row of guides and a narrow band of stereids dorsally and ventrally much as in *C. brevipilus* Bry. Eur. (plate 43), no larger cells on the ventral surface, a few cells smaller than the guides but much larger than the stereids interspersed on the

dorsal side much as shown in *C. fragilis* (pl. 48). Only sterile plants known. Type locality, sandy soil near Southport, N. Carolina, March 27, 1938 (L. E. Anderson & A. W. Evans, no. 6180). Pl. 122.

Clearly a close relative of the European *C. brevipilus* and resembling it in many particulars, but the dorsal and ventral surface cells of the costa are quite different, the toothed awn is much longer, and only occasionally hyaline and the leaf margins are serrulate some distance below the excurrent costa.

SYRRHOPODON GAUDICHAUDII Mont. Ann. Sci. Nat. II. 2: 366. pl. 16, f. 3. 1845.

Plants in compact green tufts, showing the conspicuously white leaf bases; stems branching, 1-3 cm. high; stem leaves more or less twisted and crispate when dry, from an obovate or oblanceolate erect base narrowed to a linear-lanceolate deeply grooved point once or twice the length of the base, nearly or quite entire except at the broadly acute denticulate apex, bordered by a mostly cylindric band of stereid cells extending from or near the apex to the basal part; costa not quite percurrent, smooth on both sides except at the denticulate apex, about 1/6 the width of the leaf at the middle, in cross section with a row of about 4 median guides with a stereid band on each side, the dorsal much the larger, outer cells not differentiated; cells of the upper part of the leaf rather obscure, about 6 μ in diameter, densely papillose on both sides; cancellinae filling most of the basal part of the leaf, somewhat rounded or truncate above; outer perichaetial leaves little different, the 2-3 inner much smaller, of mostly hyaline cells, often slightly serrulate. Dioicous; male plants about like the fertile, often with several antheridial buds aggregated near the apex of the stem, antheridia few, without paraphyses, enclosed by several short ovate leaves which are brownish, costate and serrulate; seta up to 6 mm., not quite smooth above; capsule erect, oblong, urn scarcely 1.5 mm. long; operculum convex-conical and rostrate, about 1 mm. long; peristome teeth golden brown, not quite smooth, lanceolate, entire, projecting about 80 μ above the rim of the capsule, with rather prominent articulations; spores rough, 12-14 μ in diameter. Type locality, Isle of St. Catherine, Brazil.

ILLUSTRATIONS:—Mont. l. c.; Williams, Bull. Torr. Club 47: pl. 15, f. 7; Pl. 121.

Highlands Hammock, Sebring, Florida (J. B. McFarlin), sterile plants only. The description is copied from that of Williams, Bull. Torr. Club 47: 374. 1920.

In the Key, p. 129, this will key out to *S. texanus*, from which it is easily distinguished by the margin entire except at apex.

CALLIERGON WICKESII n. sp.

Plantae minimae; folia caulis oblonga vel obovata, 1-1.6 mm. longa; costa valida, in folia superiora longitudine $\frac{3}{4}$ foliorum; cellulae mediae lineare-flexuosae, 60 μ longae.

Plants small, intertangled with other hydrophytic mosses; stems julaceus with the appressed leaves when dry, sparingly branched; upper oblong, apiculate, often cucullate with incurved apiculus, reaching 1.6 mm. in length, the lower obovate and broadly obtuse, shorter, mostly not apiculate or cucullate; costa strong in the upper leaves, reaching about $\frac{3}{4}$ the length of the leaves, shorter and sometimes forking in the lower leaves; median leaf cells linear-flexuose, reaching 60 μ in length, in the older leaves incrassate with lumen little wider than the somewhat porose cell walls; apical cells shorter and broader; the basal also shorter and broader, a few at the extreme angles somewhat inflated and becoming very thick-walled and colored with age. Plate 124, fig. B.

Type in herbarium of A. J. Grout. Type locality, Labrador (Wickes 1938).

Distinguished from *C. sarmentosum* by its broad short leaves, shorter costa and less differentiated alar cells. From *C. stramineum* by the relatively broader and more concave apiculate leaves.

CORRECTIONS TO VOL. I.

P. 4. Dr. H. S. Conard calls attention to the fact that in *Andreaea crassinervia* the costa is wide and gradually merges into the lamina while in *Rothii* it is marked off into a distinct subcylindric ridge.

P. 14. A specimen of *Fissidens sublimbatus* from Columbia, Missouri (Drew) has leaves more acute than in the type, cells of vaginant lamina larger and not in distinct rows; operculum more longly rostrate.

P. 14. Also *Fissidens exiguus* has been collected in Reynolds Co., Mo. (Drew).

P. 16. *Fissidens obtusifolius kansanus*, Cumberland Falls, Kentucky (Welch).

P. 17. *Fissidens Garberi*, Fayette, Wisconsin (Cheney 1891); the illustration is plate 7A, not 15A.

P. 23. Lines 7 and 11 from bottom, *F. Julianus* instead of *F. fontanus*.

P. 24. Dr. T. C. Frye reports that A. S. Foster collected *Bryoxiphium norvegicum* on Mt. Rainier.

- P. 45. The seta of *Ditrichum ambiguum* is sometimes yellow or orange when young.
- P. 47. The report of *Ditrichum giganteum* from Michigan seems to be an error.
- P. 55. *Dicranella Grevilleana* occurs in Keweenaw Co., Michigan (see *Rhodora* 1937, p. 39).
- P. 67. *Oncophorus polycarpus strumiferus*, near summit of Mt. Monadnock, New Hampshire; Catskill Mts., N. Y. (Mrs. Inez M. Haring).
- P. 69. *Oncophorus Schisti*, Keweenaw Peninsula, Michigan (Steere).
- P. 73. *Dicranoweisia crispula*, Mt. Washington, New Hampshire.
- P. 81. The capsules of *Dicranum fuscescens* are sometimes slightly strumose.
- P. 101. Type species of *Atrichum*, *A. undulatum* (Hedw.) P. B.
- P. 101. *Atrichum crispum*: Sull. & Lesq. Musci Bor. Amer. 315.
- P. 102. *A. undulatum*: Sull. & Lesq. Musci. Bor. Amer. 313; the var. *Selwyni*, Drumm. Musci Amer. 66 (as *Polytrichum undulatum*).
- P. 104. *A. angustatum*: Drumm. Musci Amer. 285 (one package almost pure, another about half *A. angustatum* and half *A. undulatum*), Macoun 215; Sull. Musci Allegh. 118, Sull. & Lesq. 314.
- P. 105. *A. papillosum* is a synonym of *A. Macmillai*, Vermont (Grout); common, S. Atlantic States.
- P. 107. *Oligotrichum parallelum*: Leiberg & Sandberg West Amer. plants 867 (as *Atrichum parallelum*).
- P. 108. *O. aligerum*: Drumm. Musci Amer. 448 (as *Polytrichum hercynicum*); Mosses of Harriman Alaska Exped. 658.
- P. 114. *Pogonatum pensilvanicum*: Sull. Musci Allegh. 116 (as *P. brevicaulis*), Sull. & Lesq. 316 (as *P. brevicaulis*).
- P. 115. *P. brachyphyllum*: Sull. Musci Allegh. 117, Sull. & Lesq. 211, 217; north to Connecticut and Long Island, N. Y.
- P. 115. *P. contortum*: Macoun 220 (as *P. alpinum*).
- P. 116. *P. urnigerum*: Sull. Musci Allegh. 114, Sull. & Lesq. 319.
- P. 117. *P. capillare*: Sull. Musci Allegh. 115 (as *Polytrichum capillare*), Sull. & Lesq. 318; Connecticut, New Jersey, Michigan as *P. alpinum*, Connecticut (See Evans and Nichols, Bryoph. Ct.).
- P. 121. *Polytrichum gracile*: Sull. & Lesq. 324 (Exsiccati, omit 1106 in second line).
- P. 122. *P. ohioense*: Sull. Musci Allegh. 110 (as *P. formosum*).
- P. 124. *P. commune*: Drumm. 72, 275 not 279, Macoun 225, Sull. Musci Allegh. 109, Sull. & Lesq. 329; the var. *perigoniale*, Sull. & Lesq. 330.
- P. 125. *P. norvegicum*: Macoun 218 (as *Oligotrichum aligerum*), also 192a and 428 (both as *P. sex-angulare*).
- P. 126. *P. juniperinum*: Sull. Musci Allegh. 112; var. *alpestris*, Sull. Musci. Allegh. 113.
- P. 128. *P. piliferum*: Macoun 222, Sull. Musci Allegh. 111, Sull. & Lesq. 325.
- P. 131. *Syrrophodon ligulatus*, Pensacola, Florida (McFarlin).
- P. 141. *Encalpyta rhabdocarpa*, northern Michigan (Nichols); Arizona, Washington, Oregon.
- P. 144. *E. procera*, northern Michigan (Nichols); Lockport, Illinois.
- P. 145, line 38: *Encalpyta streptocarpa* has also been reported from Lockport, Illinois. Its range extends from Labrador to North Carolina, Pennsylvania westward to northern Indiana, Illinois, and reaches its southwestern limit at Red Oak, Iowa. It extends across Canada to British Columbia and adjacent Washington, Idaho, Montana, and Minnesota.
- P. 153. *Astomum phascoides* is plate 82, not 84.
- P. 155. *Weisia tortilis*, Ohio (Sharp).
- P. 157. *Weisia jamaicensis*, Pl. 82, not 84.
- P. 158. Steere, Bryol. 42: 16-22, plates 1 and 2 1939. states that Drummond's Musc. Ann. 21 is true *Gymnostomum tenue* and that Moxley has collected it at Owen Sound, Ontario. It is further distinguished from *G. calcareum* by the lack of distinct stereid bands in its costa.
- P. 159. Holz. Musc. Acro. Bor. Am. 331 not 311 ?
- P. 166. *Tortella caespitosa* should be *T. humilis* (Hedw.) Jennings, Mosses W. Pennsylvania, 95. 1913.
- P. 166. *Barbula humilis* Hedw. Sp. Musc. 116. 1801.
- P. 167. *Tortella flavovirens* is plate 78, not 82.
- P. 188. *Didymodon rigidulus* Hedw. Tennessee (Sharp).
- P. 191. Key to the *Trichostomeae* 11, *Barbula* is number 14, not 15. 15, second line should read, Leaves bi-tri-stratose except along the margins.

ADDITIONS AND CORRECTIONS TO VOL. III.

P. 22. *Eurhynchium riparioides* (Hedw.) Sharp, Bryol. 41: 126. 1938, supersedes *E. rusciiforme* (Neck.) Milde. (*Hyponum riparioides* Hedw. Sp. Musc. 242. 1801.)

P. 50. BRACHYTHECIUM CAVERNOSUM Kindb. (See Vol. III, p. 50.)

The illustration, *pl. 127*, was made from specimens collected by Brinkman at Glacier, British Columbia and identified by Kindberg himself. They agree with Kindberg's meager original description except as regards the basal and alar cells, which are likely to remain on the stem unless removed with considerable care.

The ovate and acuminate leaves are much like the stem leaves of *B. oxycladon* except that they are conspicuously decurrent with alar cells less numerous, considerably enlarged and oblong-hexagonal instead of small and quadrate. A row or two of these enlarged cells runs across the base of the leaf at the insertion. The cortical cells of the stem, often removed on the leaf base, are about the width of the median leaf cells.

The plicate leaves and different alar cells distinguish this species at once from *B. rutabulum*; the much less inflated and less numerous alar cells from *B. rivulare*. There were no sporophytes on the Brinkman plants but as Kindberg compared his fruiting plants with *B. rutabulum* and *B. rivulare*, the seta is probably rough. In that case it will key out to *B. lamprochryseum* or *B. asperrimum*, with which it is not likely to be confused.

BRACHYTHECIUM HOLZINGERI Grout (see Vol. III, p. 50).

Mr. A. H. Brinkman has sent me enough of his no. 325, the collection from Kamloops, British Columbia mentioned in the Bryologist 25: 14. 1922, to use as no. 66 of my Musci Pleurocarpi Supplement.

In spite of my statements in Vol. III, p. 50, I am now convinced, after a careful comparison, that the Sperry Glacier plants (see Bryol. 4: 48. 1901) are not typical of this species but are a poorly developed form of it. As these were described as a variety *B. collinum*, the Brinkman plants should be considered the type.

Dr. Flowers' illustration (*plate 120*) from the Kamloops plants are excellent and will give a better idea of the species than any description. From *B. collinum*, to which it will key out, and to which it is more closely related than any other American species, it is distinguished by its more robust size, larger and much more slenderly acuminate leaves, and more strongly papillose seta. Mrs. MacFadden has collected a more slender form of this species at Sandon, British Columbia (no. 696), Oct. 11, 1927.

P. 150. Type species of *Mittenothamnium* is *M. reptans* (Hedw.) Card.

P. 204. By agreement of the International Botanical Congress *Haplohymenium* is made a nomen conservandum with type species *H. triste* (Cesati) Kindb.

P. 205. Add to the footnote: sterile *Thuidium abietinum*.

P. 213. *Papillaria* has been made a nomen conservandum, hence *P. nigrescens* (Sw.) Jaegr. & Sauerb. supersedes *Tricholepis nigrescens* (Sw.) Grout.

P. 208. Type species of *Neckera* is *N. pennata* Hedw., not *N. crispa* Hedw.

This has no connection with Vol. III, but is a last minute addition.

FISSIDENS ANDERSONI n. sp.

Plantae 4-6 mm. altae; folia 6-8 juga, oblonga vel lanceolato-oblonga, 1.4 x 0.5 mm. acuta; lamina duplicaturae limbata; costa sub apice finiente; cellulae hexagonae, leves, 10-15 mm. latae; archegonia in apice caulis.

Plants up to 6 mm. long, rarely branching; leaves contorted to slightly crisped when dry, oblong to oblong-lanceolate, up to 1.4 x 0.5 mm., mostly smaller, abruptly to gradually acute, up to 8 or more pairs in number; vaginant laminae extending about $\frac{1}{2}$ the length of the leaf; bordered in the fertile stems by a narrow band of 2-3 narrowly linear cells, which towards the leaf base are usually reduced to a single row inside of a row or two of quadrate marginal cells; dorsal and apical laminae not bordered; in some sterile plants the border is present in the upper leaves only; margins entire, without papillae; upper leaf cells hexagonal, somewhat irregular, 12-15 μ in diameter, smooth, sometimes somewhat bulging-mamillose; basal cells more elongate and rectangular; costa usually ending two or more cells below the apex but occasionally percurrent. Only undeveloped terminal archegonia found, with perichaetial leaves not fully developed.

Type from wet soil, floor of cypress swamp near Currituck, Currituck Co., N. Carolina, May 15, 1939, Lewis E. Anderson, no. 6505. Type in herb. Duke University, cotype in herb. A. J. G.

The larger smooth cells distinguish this species easily from *F. Ravenelii* and *F. Garberi*, which plainly show papillae along the marginal cells. The leaves of *F. Neoni* are entirely different, smaller, ovate, with elongate cells and border often found on dorsal lamina.

The plants have been checked against all the Mexican and West Indian plants reported in the second edition of Engler & Prantl, except those which Paris reports from "Guadalup" only.

The illustration of the border in the vaginant lamina of *F. sublimbatus*, though much stronger, illustrates the border in this species fairly well.

DITRICHUM CURRITUCKI n. sp.

Plantae minimae; caulis 1-2 mm. altus; folia subulato-capillaria e basi lanceolata, 3-4 mm. longa; costa latissima, excurrens; seta 0.7-1 cm. longa; capsula ovata, 1 mm. longa deoperculata, annulata; dentes peristomii prope ad basin fissi, papillosissimi.

Plants small, yellowish-green; stems simple, 1-2 mm. long; leaves long filiform-subulate from a lanceolate base, up to 4 mm. long, channelled above, entire except at and near the apex, more or less secund especially at the stem ends, little changed in drying; costa very wide, up to $\frac{3}{4}$ the width of the leaf base and occupying nearly all the subula, long excurrent; basal leaf cells rectangular, 2-4 : 1, narrower at the margin, smaller above and about 5 μ wide; inner perichaetial leaves from an oblong sheathing base gradually narrowed to an even more filiform or capillary subula which is usually entire and much longer than the sheathing base, often only a single cell wide at the apex, basal cells of the sheathing portion oblong-hexagonal, slightly inflated, 75-120 x 20-25 μ . Seta reddish-yellow, up to 1 cm. long; capsule ovoid, largest in the middle, urn up to 1 mm. long, nearly or quite symmetric, often inclined, often showing a very slight struma, antheridia, calyptra and operculum not found; peristome of 32 filiform segments from a low papillose basal membrane, spinose-papillose as in *D. pallidum*, up to 180 μ long; annulus apparently of a single row of large cells, partially persistent in old capsules; spores 22-25 μ , rough with coarse irregular papillae as in *D. pallidum*. Type locality, near Currituck, Currituck Co., North Carolina, May 13, 1939, L. E. Anderson and A. J. Grout.

This species clearly belongs in the group with *D. pallidum* and *D. Schimperii*. From the former it differs in its smaller size, especially the shorter and less brilliantly yellow seta, and shorter unfurrowed capsule, which is only shrunken when dry and empty, in the much larger spores and wider costa. From the latter, while it has the large spores, it differs in the other particulars mentioned under *D. pallidum*, also in the teeth, as strongly papillose as in that species.

It is nearest of all to the European *D. subulatum* (Bruch) Hampe. From that it differs in its wider costa, leaves more gradually narrowed from the basal portion, more slender subula, well developed annulus of large cells and larger spores.

From the tropical *D. rufescens* (Hpe.) Broth. it differs in much the same particulars as from *D. pallidum*, also in the spores which in *D. rufescens* are smooth and 10-18 μ .

PLATE 91. *A. Acaulon rufescens* (by Seville Flowers). 1, plant $\times 25$; 2, 2, leaves right to left outer to inner $\times 30$; 3, leaf apex $\times 600$; 4, basal marginal leaf cells $\times 600$; 5, capsules $\times 75$ (lower shows exothelial cells, upper spores).

C. Leaves of Phascum cuspidatum Americanum. Fig. 2 is an unusual form (by Seville Flowers).

D. Anoetangium arizonicum (by E. B. Bartram). *a, b*, plants $\times 1$; *c, d*, stem leaves $\times 40$; *e*, apex of stem leaf $\times 250$; *f*, cross section of costa $\times 250$.

E. Rhexophyllum subnigrum (from Bartrams no. 811). 1, leaves $\times 10$; 2, cross section of lower median leaf $\times 150$; 3, cross section of upper median leaf $\times 150$; 4, leaf apex $\times 150$; 5, lower marginal leaf cells $\times 150$; 6, lower leaf cells near costa $\times 150$.

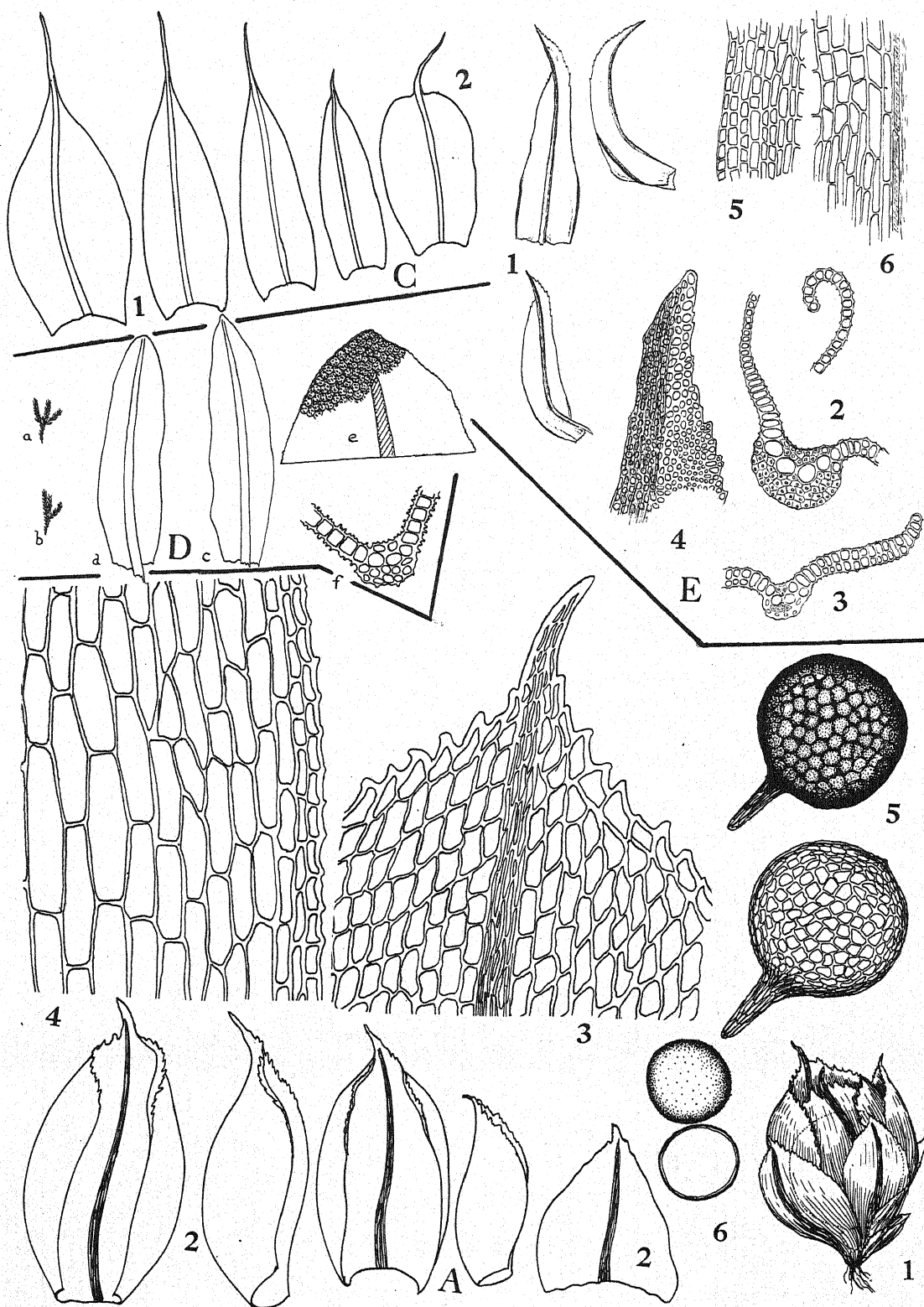


PLATE XCI

PLATE 92. A. 1a-1g. *Phascum hyalinotrichum* (from Bot. Gaz. 37: pl. 16). (All figures numbered with a letter.) a, plant $\times 17$; b, lower leaf $\times 26$; b', upper leaves $\times 26$; c, basal areolation $\times 135$; d, median leaf cells $\times 135$; e, apical leaf cells $\times 135$; f, capsule $\times 26$; g, calyptra $\times 26$.

A. *Acaulon rubrum* (from Dixon, Handb. Brit. Mosses (Ed. 1) pl. 25).

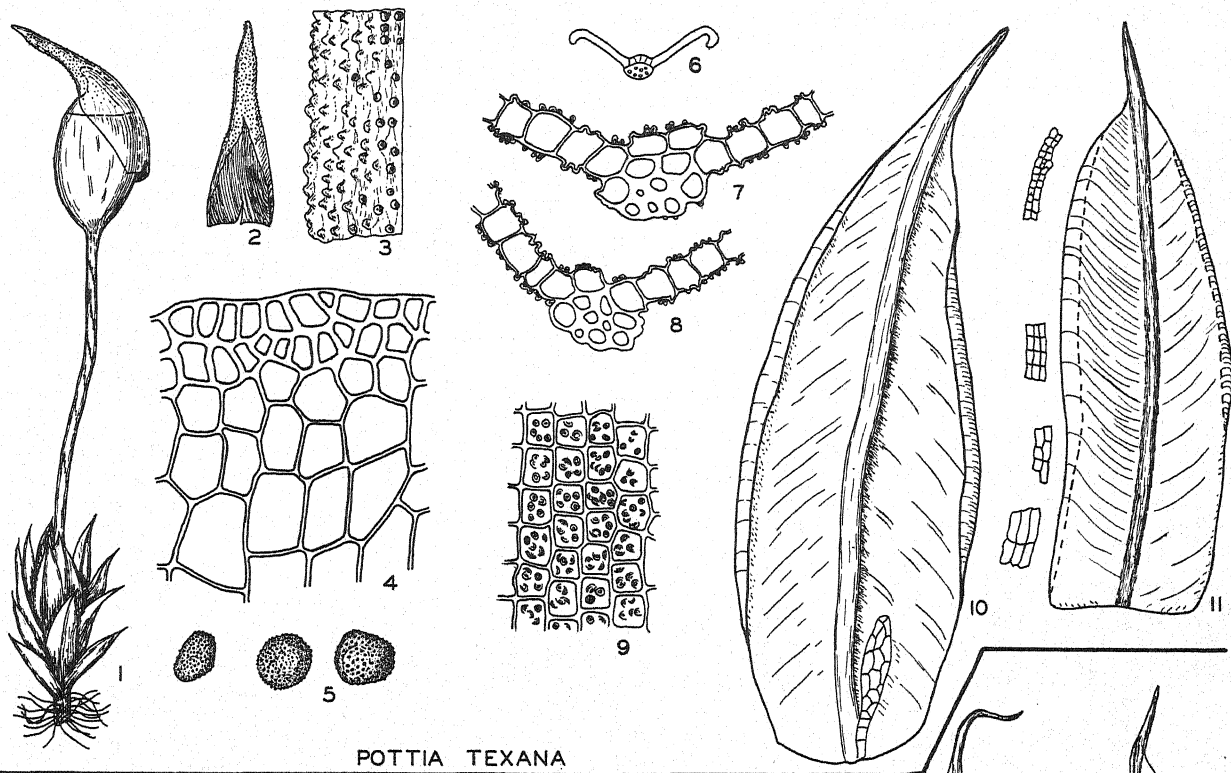
*, plant much enlarged; 3, leaf; 3a, leaf apex; 3c, upper leaf cells.

8. *Acaulon rufescens* (from Roth, Ausser Europ. Laubm. pl. 20). The figures are self explanatory.

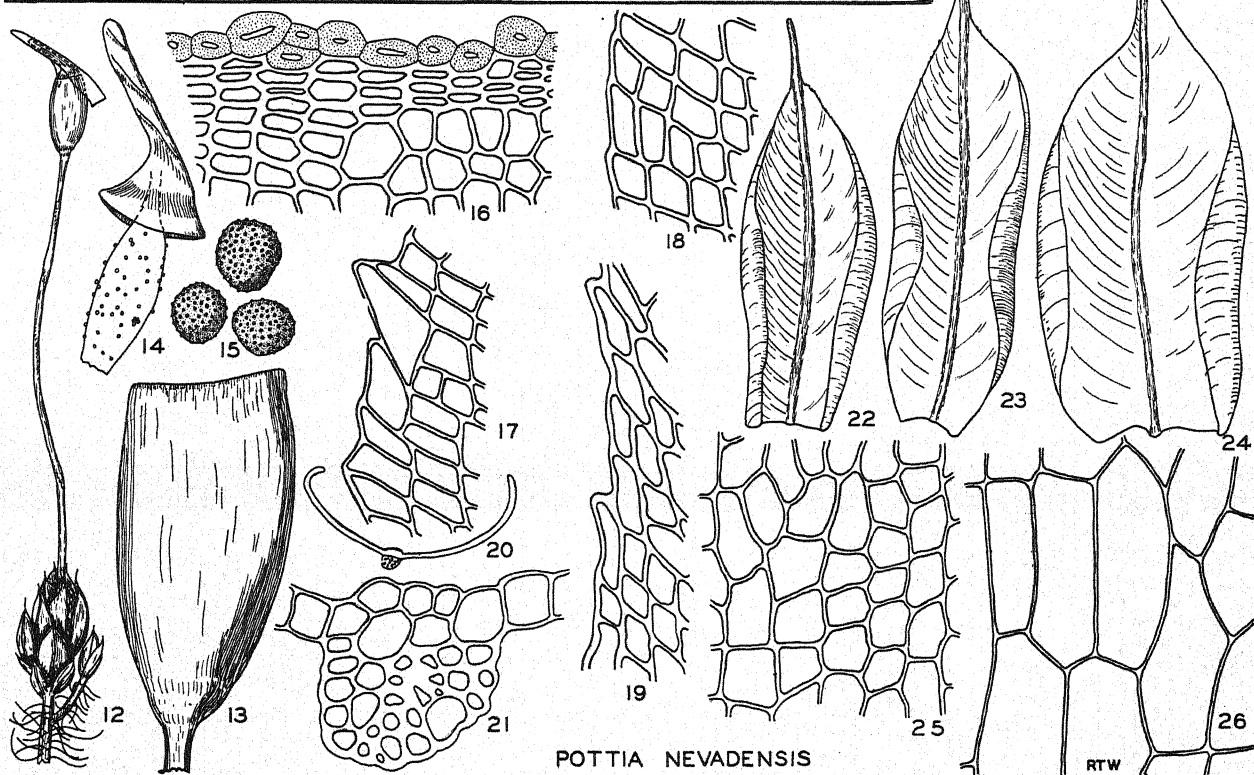
B. *Acaulon Schimperianum* (from Sull. Icones Musc. pl. 9) 2, plant much enlarged; 4, 5, leaves; 6, perichaetial leaf; 7, cross section of leaf; 8, cells of leaf apex; 9, basal cells; 10, capsule in perichaetial leaf; 12, sporophyte with calyptra; 13, dehiscent capsule; 14, spore; 15, calyptra.

PLATE 93. *Pottia texana*. 1, plant $\times 20$; 2, calyptra $\times 28$; 3, portion of upper part of calyptra $\times 308$; 4, portion of urn mouth $\times 308$; 5, spores $\times 308$; 6, outline of cross section of leaf at about the middle $\times 76$; 7, 8, cross sections of costae from two leaves at about leaf middle $\times 308$; 9, upper median leaf cells $\times 308$; 10, dorsal view of upper leaf with attached antheridium $\times 76$; 11, ventral surface of another leaf $\times 76$.

Pottia nevadensis. 12, plant $\times 6.4$; 13, urn $\times 28$; 14, lid with attached columella $\times 28$; 15, spores $\times 308$; 16, portion of urn mouth $\times 308$; 17, 18, 19, leaf margins near apex $\times 308$; 20, outline of leaf cross section at about the middle $\times 28$; 21, cross section of costa at about leaf middle $\times 308$; 22, 23, 24, ventral surface of upper leaves $\times 28$; 25, median cells $\times 308$; 26, basal cells $\times 308$.



POTTIA TEXANA



POTTIA NEVADENSIS

RTW

PLATE 94. *Pottia bryoides*. 1, plant $\times 12$; 2, 3, 4, plants $\times 8$; 5, outline of leaf cross section at leaf middle $\times 76$; 6, 7, cross sections of costae from two leaves at about leaf middle $\times 308$; 8, 9, leaves $\times 28$; 10, basal cells $\times 308$; 11, upper median cells $\times 308$; 12, cells at junction of lid and urn $\times 308$; 13, 14, longitudinal and cross sections respectively of lid. (Redrawn from Limpricht l. c. *figs. 72 and 73*; 13 has a magnification of 180 times); 15, spores $\times 308$; 16, section of lid showing spiral arrangement of cells $\times 76$; 17, capsule $\times 28$.

Pottia Randii. 18, plant $\times 8$; 19, three antheridia among paraphyses $\times 76$; 20, leaf subtending antheridia $\times 76$; 21, portion of urn mouth $\times 308$; 22, spores $\times 308$; 23, leaf cells near apex $\times 308$; 24, leaf cells at upper median portion $\times 308$; 25, marginal cells near apex $\times 308$; 26, leaf $\times 28$; 27, marginal cells just below middle $\times 308$; 28, leaf cells a little above the base $\times 308$; 29, cross section of leaf just above middle $\times 76$; 30, 31, cross sections of costae from two leaves just above middle $\times 308$; 32, cross section of margin just below middle $\times 308$; 33, cross section of margin just above middle $\times 308$:

PLATE 95. *Pottia arizonica*. 1, plant $\times 12$; 2, calyptra $\times 28$; 3, portion of upper part of calyptra $\times 308$; 4, exothecial cells $\times 308$; 5, portion of urn mouth $\times 308$; 6, urn mouth $\times 76$; 7, spores $\times 308$; 8, 9, 10, leaves $\times 76$; 11, leaf with antheridium $\times 28$; 12, outline of leaf cross section at about leaf middle $\times 76$; 13, cross section of costa at about leaf middle $\times 308$; 14, median cells $\times 308$; 15, basal cells $\times 308$.

P. arizonica var. *mucronulata*. 16, 17, leaves $\times 76$; 18, 19, urn mouths $\times 76$.

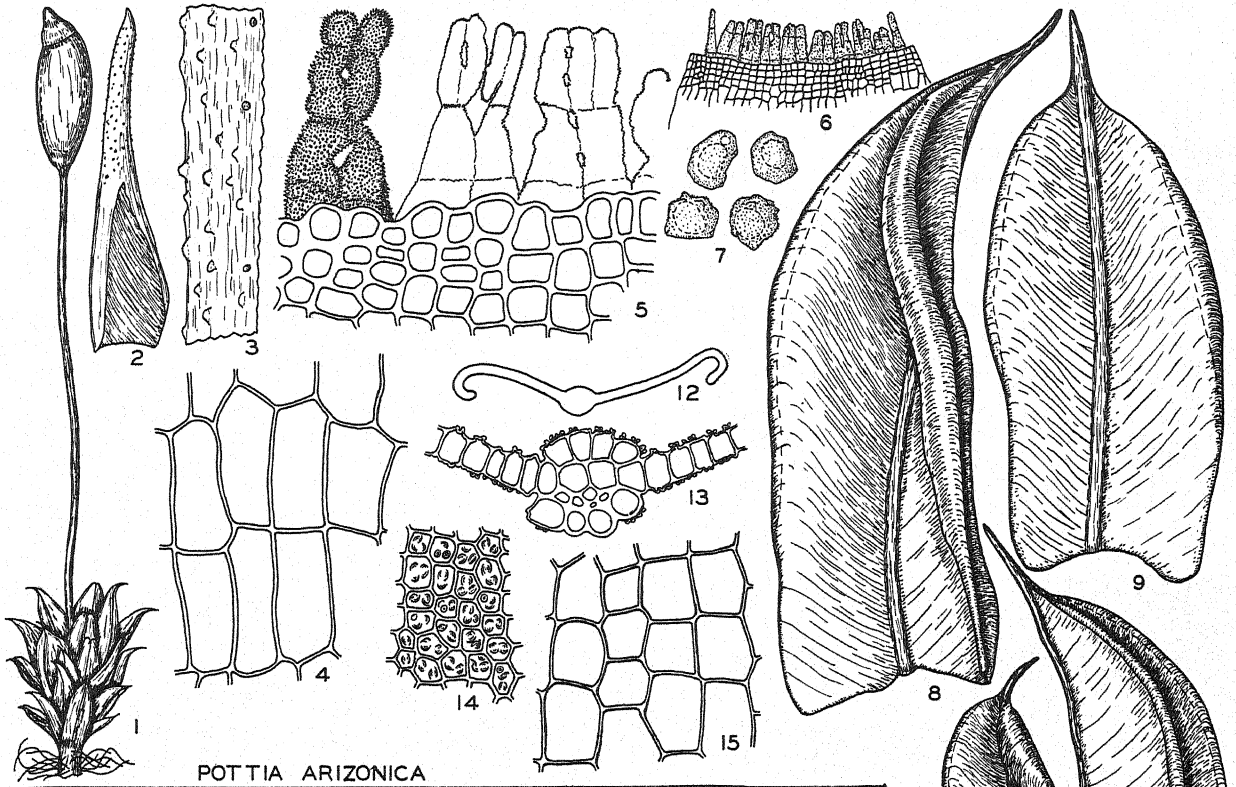
20, 21, *P. truncata*. 20, portion of urn mouth from outside showing the annular filaments $\times 308$; 21, longitudinal-radial view of annulus and annular filament $\times 308$.

22, 23, two leaves of *P. latifolia* var. *pilifera* \times about 20.

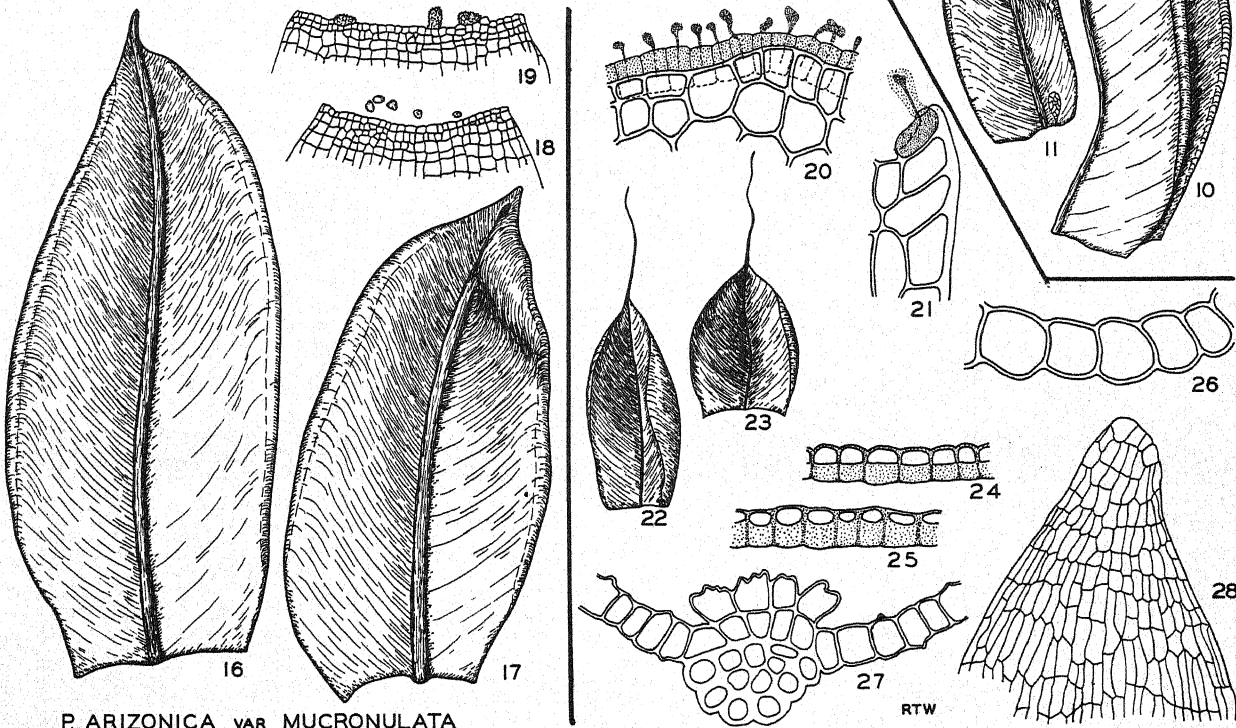
24-26, *P. latifolia*. 24, 25, cross sections of leaf cells from upper half of leaf $\times 308$; 26, cross section of leaf cells from lower half of leaf $\times 308$.

27, cross section of costa of *P. lanceolata* at about leaf middle $\times 308$.

28, tip of capsule of *P. Fosbergii* $\times 76$.



POTTIA ARIZONICA



P. ARIZONICA VAR. MUCRONULATA

RTW

PLATE 96. A. *Pottia Starkeana* (from Bry. Eur. *pl.* 125). 5-8, leaves; 6a, apical leaf cells; 6b, basal cells; 12-15, peristome teeth.

G. The same from Dixon, Handb. Brit. Mosses (Ed. 3) *pl.* 23G.

B. *Pottia latifolia* (from Bry. Eur. *pl.* 128). 1b, plant much enlarged; 2-5, leaves; 4a, apical leaf cells; 4b, basal cells; 9, 11, 13, capsules; 14, 15, 16, peristome; 17, annulus cells. β figures, var. *pilifera*.

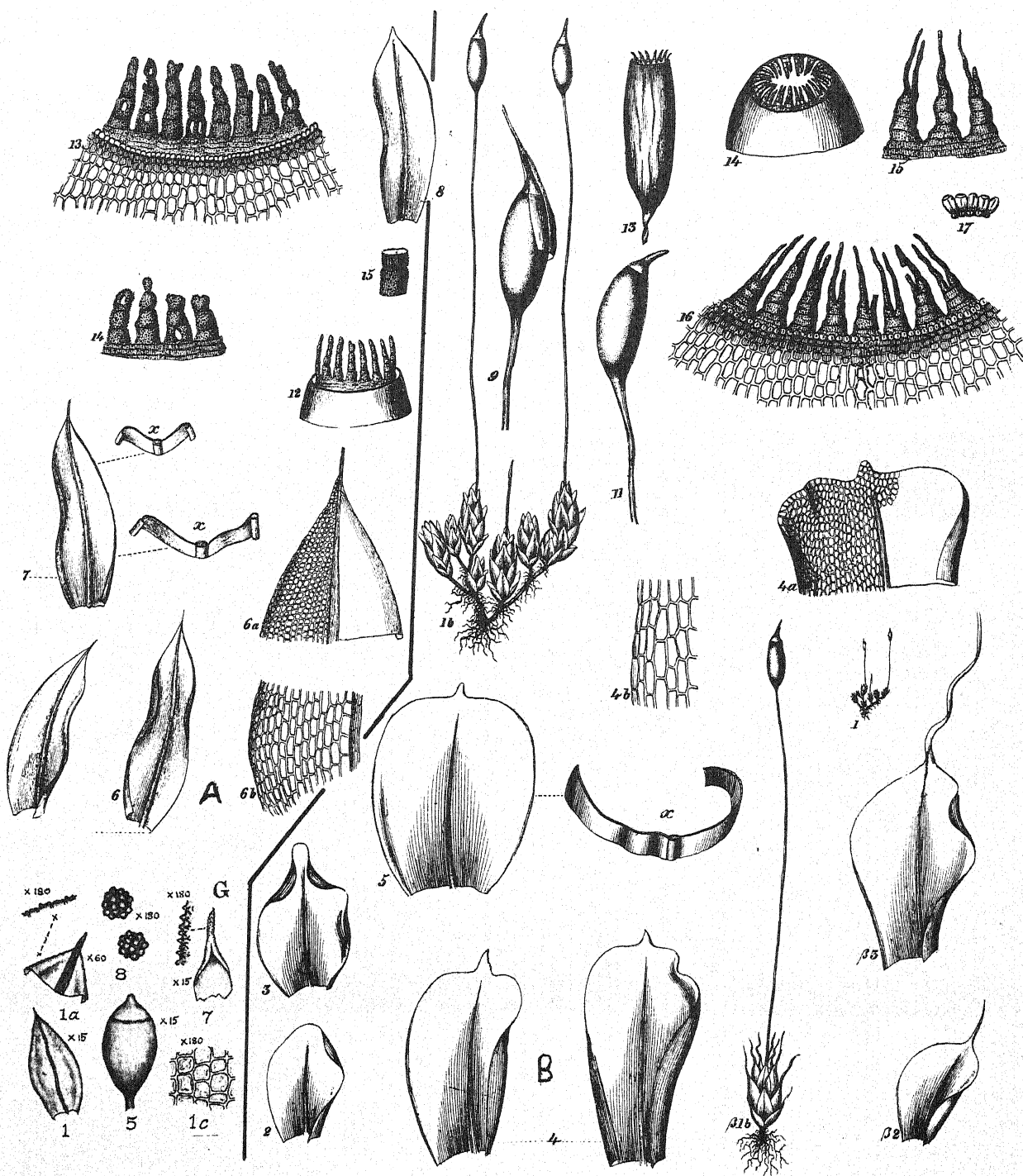


PLATE XCVI

PLATE 97. Left, *Pottia Heimii* (from Bry. Eur. *pl.* 124). 4, leaf enlarged; 4a, leaf apex more enlarged; x, cross section of leaf; 5 and 6, plant with most of the leaves removed, showing the position of antheridia and archegonia; 8, 9, antheridia, paraphyses and archegonium; 11, 12, 13, capsules; 14, mouth of capsule; 15, spores.

Right, *Pottia lanceolata* (from Bry. Eur. *pl.* 127). 4, 5, 6, leaves; 5a, 6a, leaf apices; 5b, basal cells; 7, calyptra; 14, 15, capsules; 17, 18, 19, 20, peristome teeth; 21, 22, annulus cells; 23, spores.

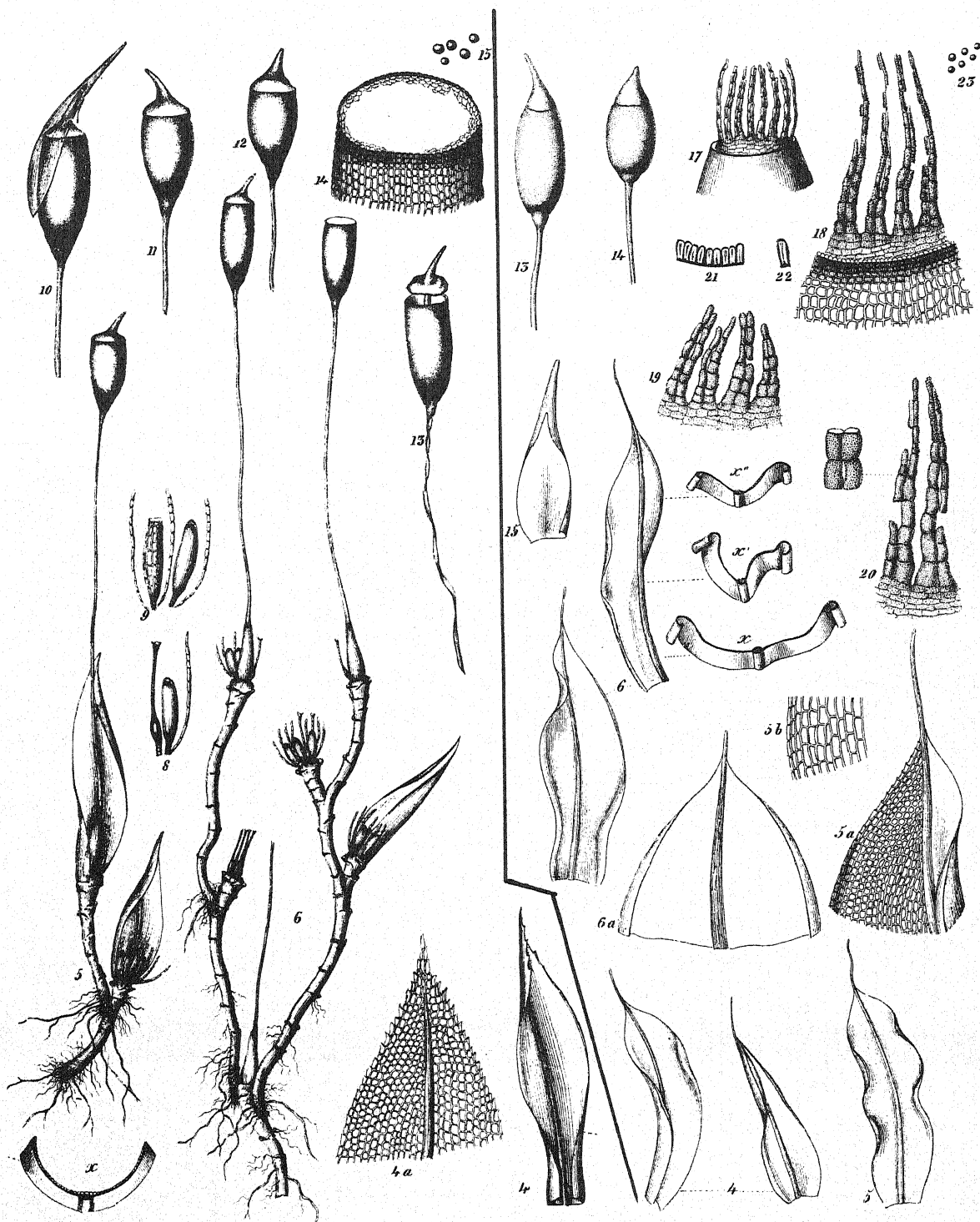


PLATE XCVII

PLATE 98. A. *Pterygoneurum ovatum* (from Bry. Eur. *pl.* 118). 3, 4, 5, leaves much enlarged; 4x, 5x, cross sections of leaves; 5a, leaf apex; 8, portion of stem with archegonial and antheridial buds; 13, 14, 15, capsules; 16, capsule mouth; 17, calyptra; 18, spores; 19, antheridia and paraphyses.

B. *Pterygoneurum lamellatum* (from Bry. Eur. Suppl. *pl.* 32). 4, 5, 7, 8, leaves; 5x, cross sections of leaf; 6a, cells of leaf apex; 6b, cells of leaf base; 9, capsule; 10, stem showing position of archegonia and antheridia; 17, operculum showing spiral arrangement of tissues; 24, diagram of cell arrangement in the same; 21, mouth of capsule showing annulus and peristome teeth; 22, portion of capsule mouth more enlarged and showing annulus cells.

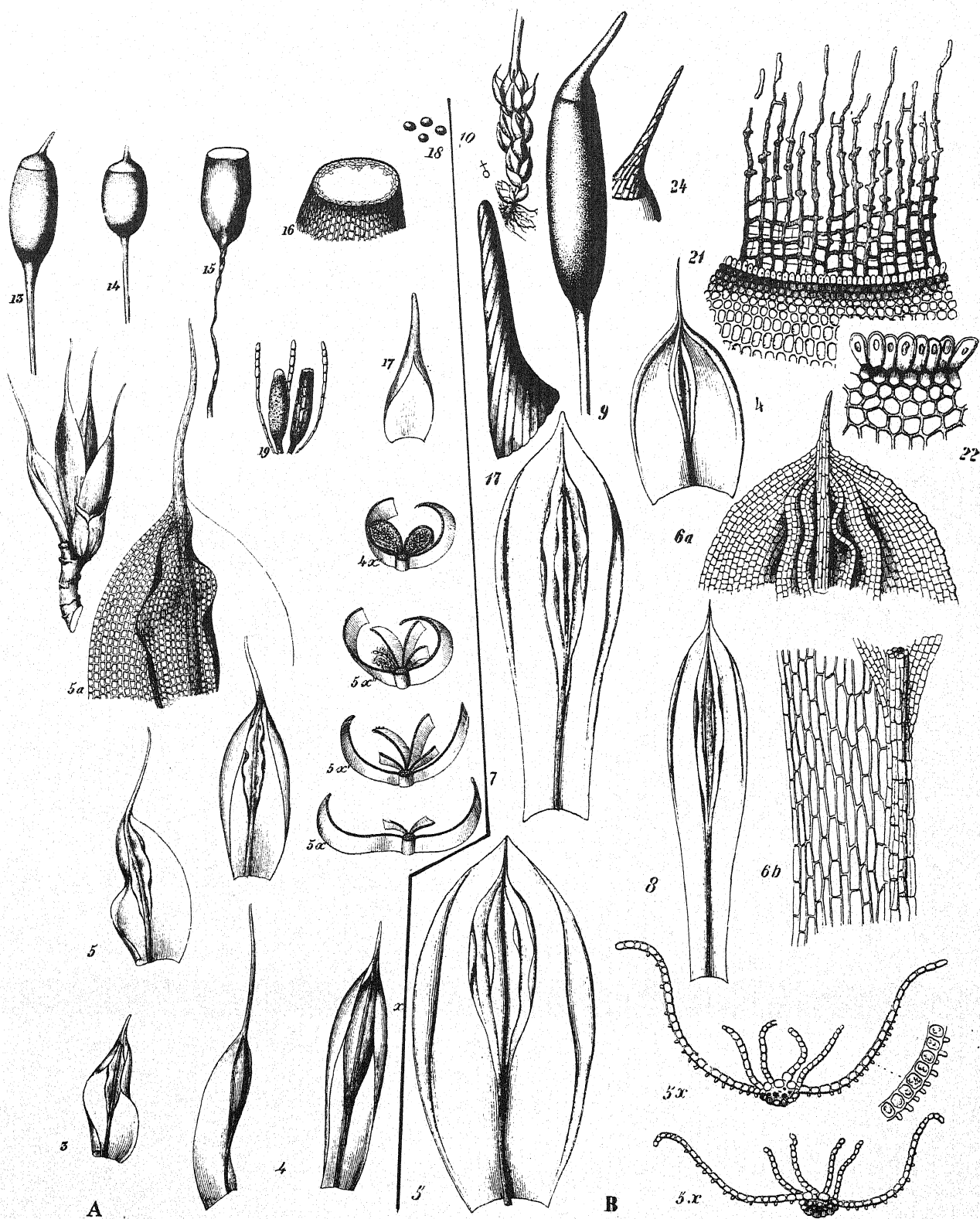


PLATE XCVIII

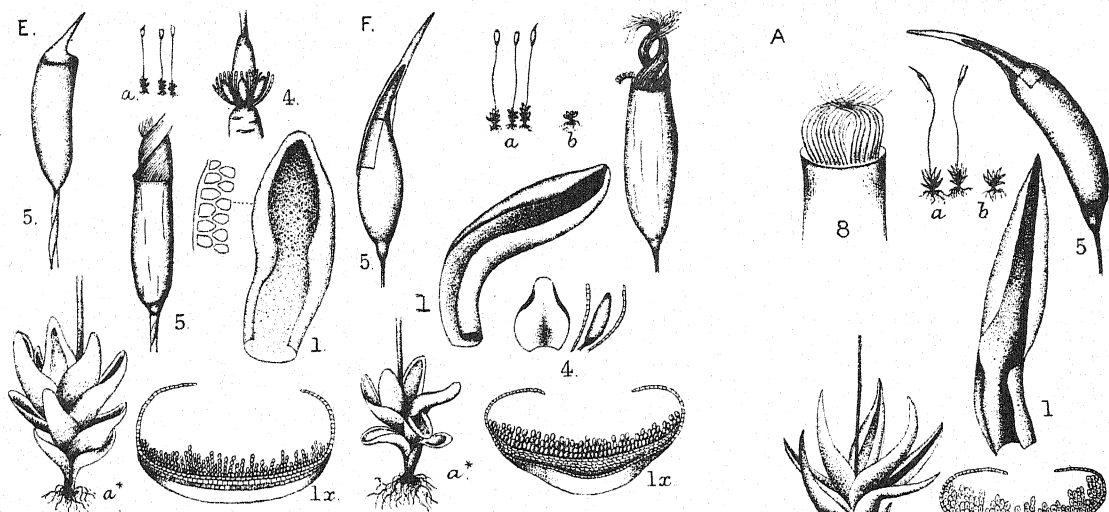
PLATE 99. A. *Aloina aloides*. a, plants natural size; 1, leaf much enlarged; 1x, cross section of leaf. Other figures are self explanatory.

B. *Pterygoneurum subsessile* var. *Henrici* (from drawings by R. T. Wareham). 1, leaf apex much magnified; 2, leaf from archegonial tip.

C. *Crossidium griseum* (a-e from Limpr. Laubm. 1: 644, fig. 181; g, from drawing by Dr. Flowers). a, plant $\times 10$; b, leaf $\times 24$; c, cross section of leaf $\times 175$; d, operculum $\times 23$; e, peristome $\times 150$; g, peristome from an American plant $\times 300$.

E. *Aloina brevirostris*. Explanation as for A.

F. *Aloina rigida* (as *Tortula stellata*). Explanation as for A. (A, E, & F from Braithw. Brit. Moss Fl. 1: pl. 30 and 31.)



Tort. brevisrostris

Tortula stellata

Tort. aloides

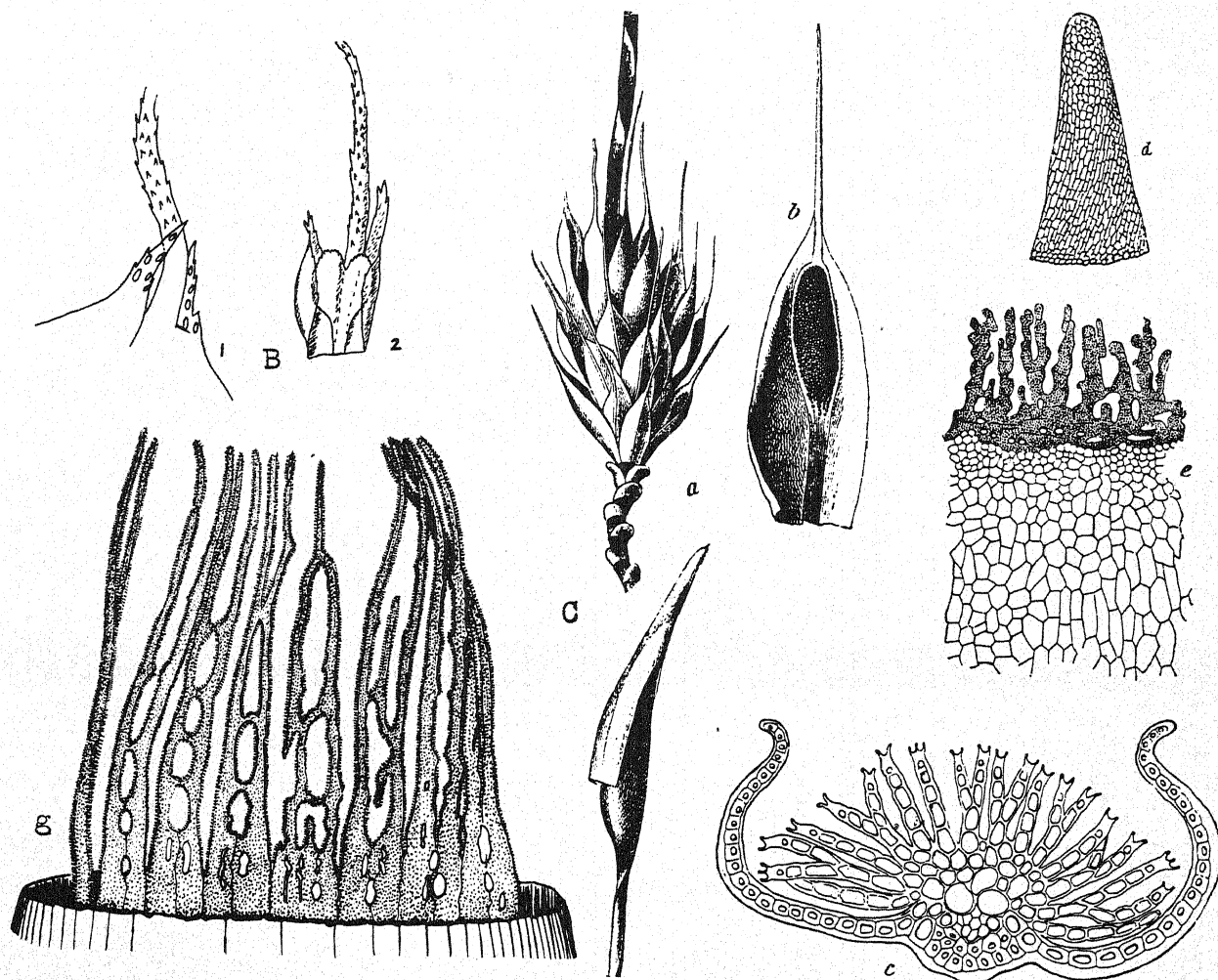
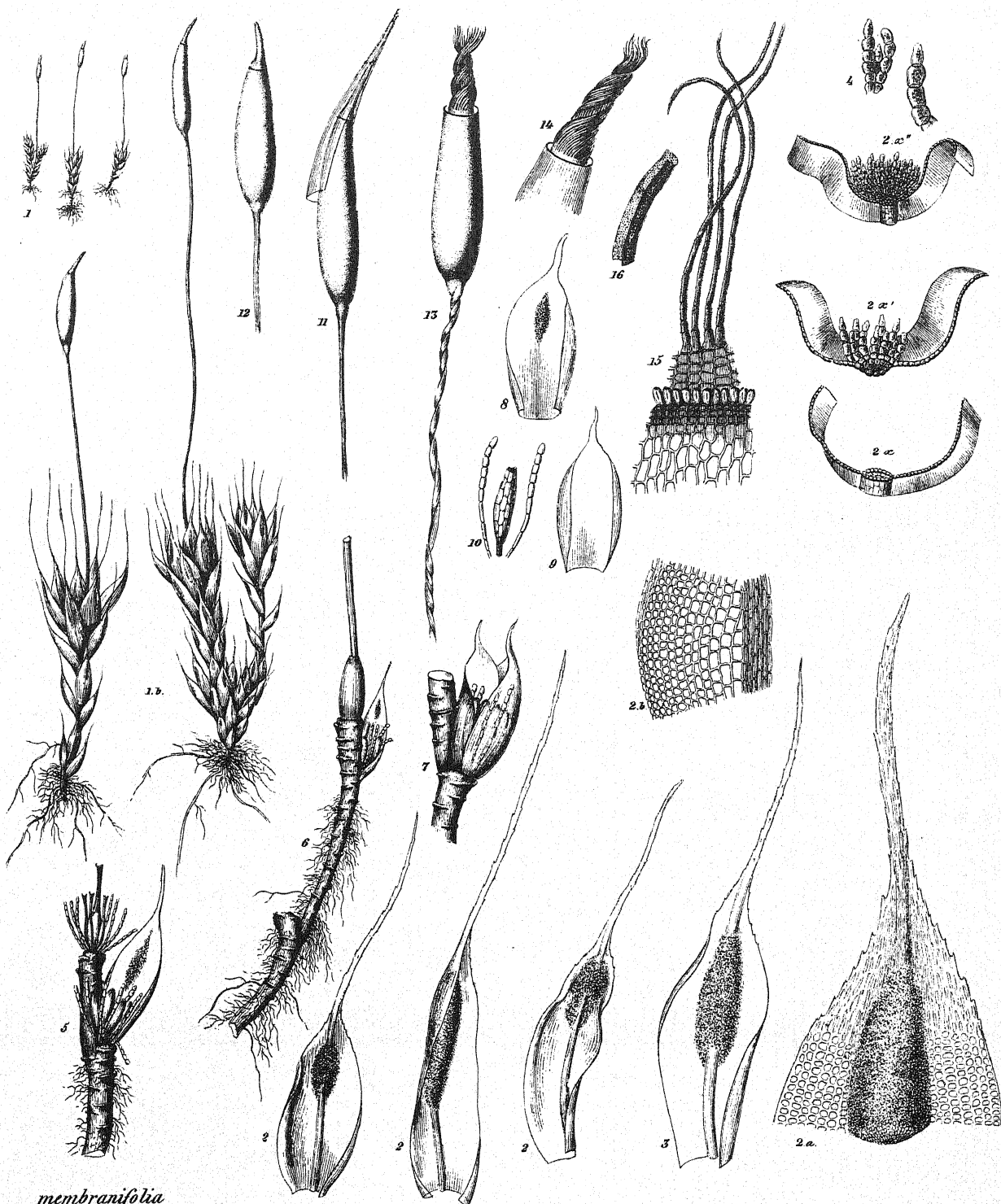


PLATE 100. *Crossidium squamigerum* (from Bry. Eur. pl. 140, as *Barbula membranifolia*). 1, plants $\times 1$; 1b, plants enlarged; 2, 3, leaves; 2a, apical leaf cells; 2b, basal cells; 2x, cross sections of leaf at different points; 4, costal filaments; 5, 6, portions of stem showing position of antheridia and archegonia; 7, antheridial bud; 8, 9, perigonal leaves; 10, antheridium and paraphyses; 11, 12, 13, capsules; 14, 15, 16, peristome and teeth.



membranifolia

PLATE 101. A. *Crossidium desertorum* (from Bryol. 26: pl. 6). 1, 2, stem leaves $\times 70$; 3, costal filaments $\times 425$; 4, upper leaf cells $\times 425$; 5, section of upper leaf $\times 70$.

B. *Crossidium erosum* (from Bryol. 27: pl. 1). 1, plant $\times 1.2$; 2, stem leaf $\times 30$; 3, apex of stem leaf $\times 180$; 4, part of upper stem leaf $\times 30$; 5, basal cells of stem leaf $\times 180$; 6, mouth of capsule, annulus and operculum $\times 30$; peristome $\times 30$ (poor); 8, costal filaments $\times 180$.

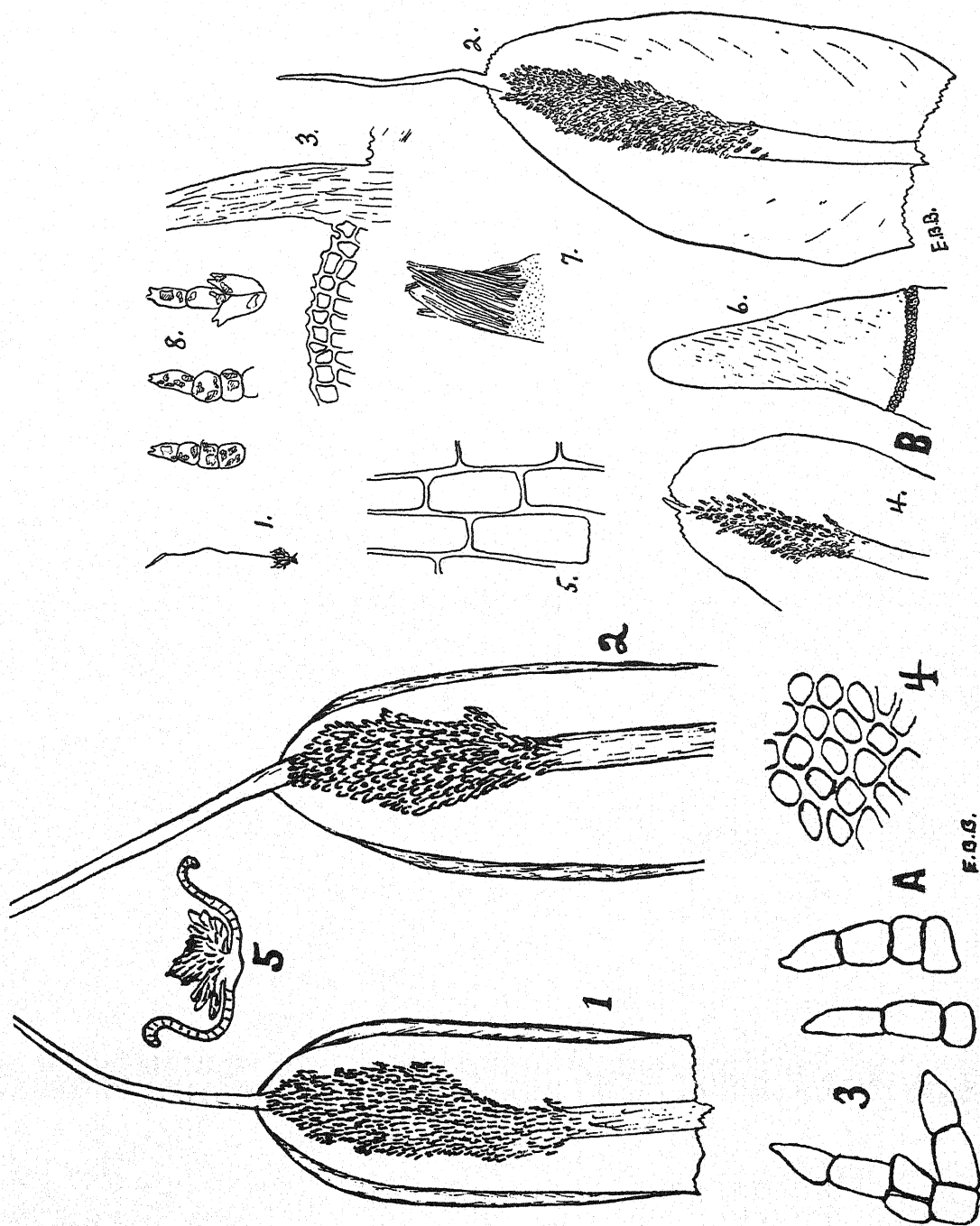


PLATE CI

PLATE 102. A. *Crossidium aberrans* (from Bryol. 27: pl. 2). 1, 2, 4, stem leaves $\times 50$; 3, upper leaf cells $\times 300$; 5, costal filaments $\times 300$.

B. *Crossidium spatulaefolium* (Bryol. 27: pl. 3). 1, plant $\times 1.2$; 2, perichaetial leaf $\times 30$; 3, stem leaf $\times 30$; 4, basal cells of perichaetial leaf $\times 180$; 5, operculum $\times 30$; 6, costal filaments $\times 180$; 7, spores $\times 180$.

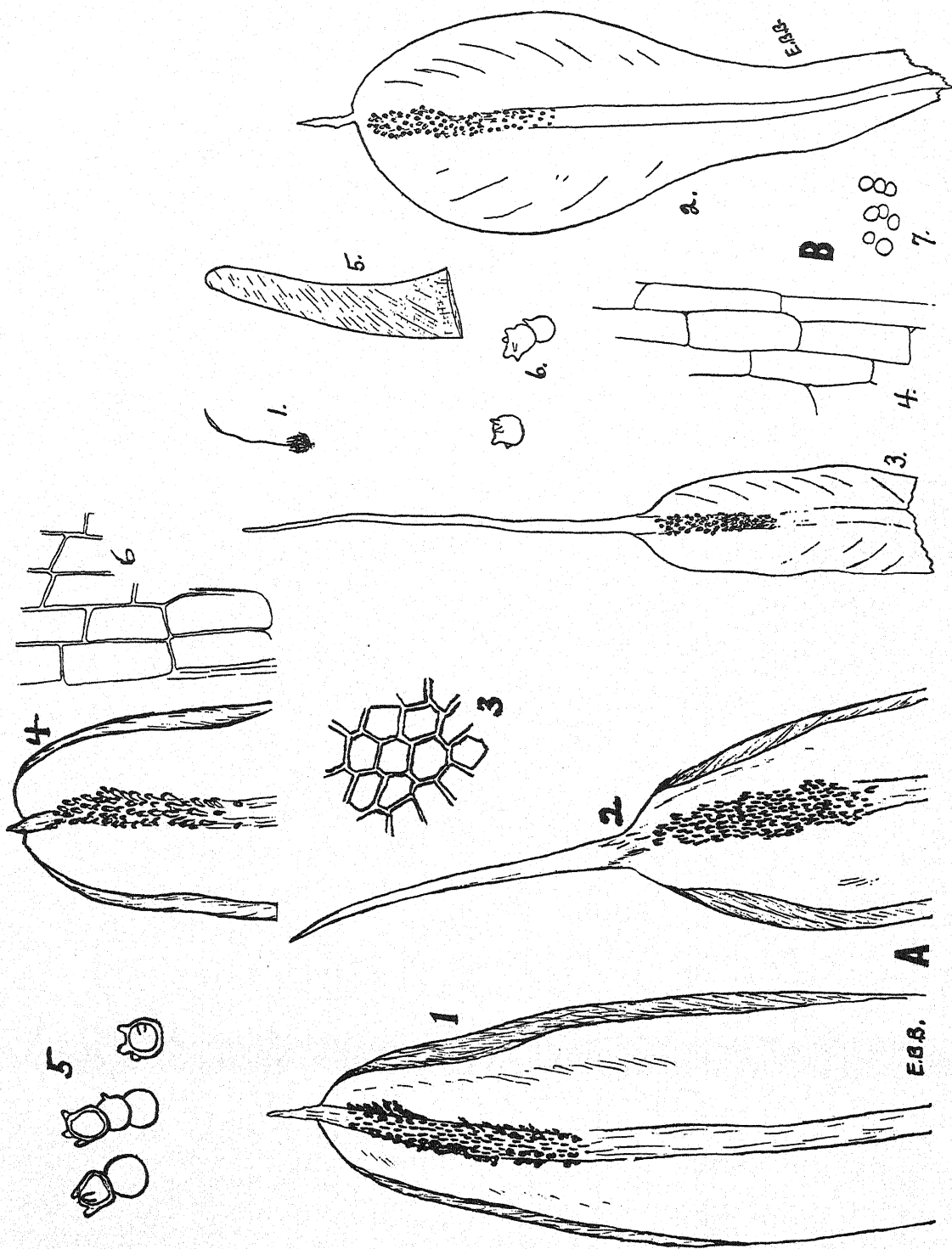


PLATE CII

PLATE 103. A. *Tortula inermis* (from Bry. Eur. pl. 164). 2, plant much enlarged; 4, 5, 6, leaves; x, cross sections of leaf; 5a, leaf apex; 7, capsule; 8, operculum showing spiral arrangement of cells; 9, peristome.

B. Cross sections of leaves of *Desmatodon* species (from Bull. Torr. Club. 46: pl. 11, all $\times 270$). 1, *D. latifolius*; 3, *D. Guepini*; 4, *D. plinthobius*; 5, *D. obtusifolius*; 6, *D. Porteri*; 7, *D. systilius*; 8, 9, *D. Sprengelii* (8, published as *D. Garberi*).

X. *Pottia Fosbergii* (from Bryol. 33: pl. 2). A, plants $\times 2$; B, plant $\times 18$; C, leaves $\times 88$; D, lower leaf cells $\times 500$; E, upper leaf cells $\times 500$; F, spore $\times 500$.

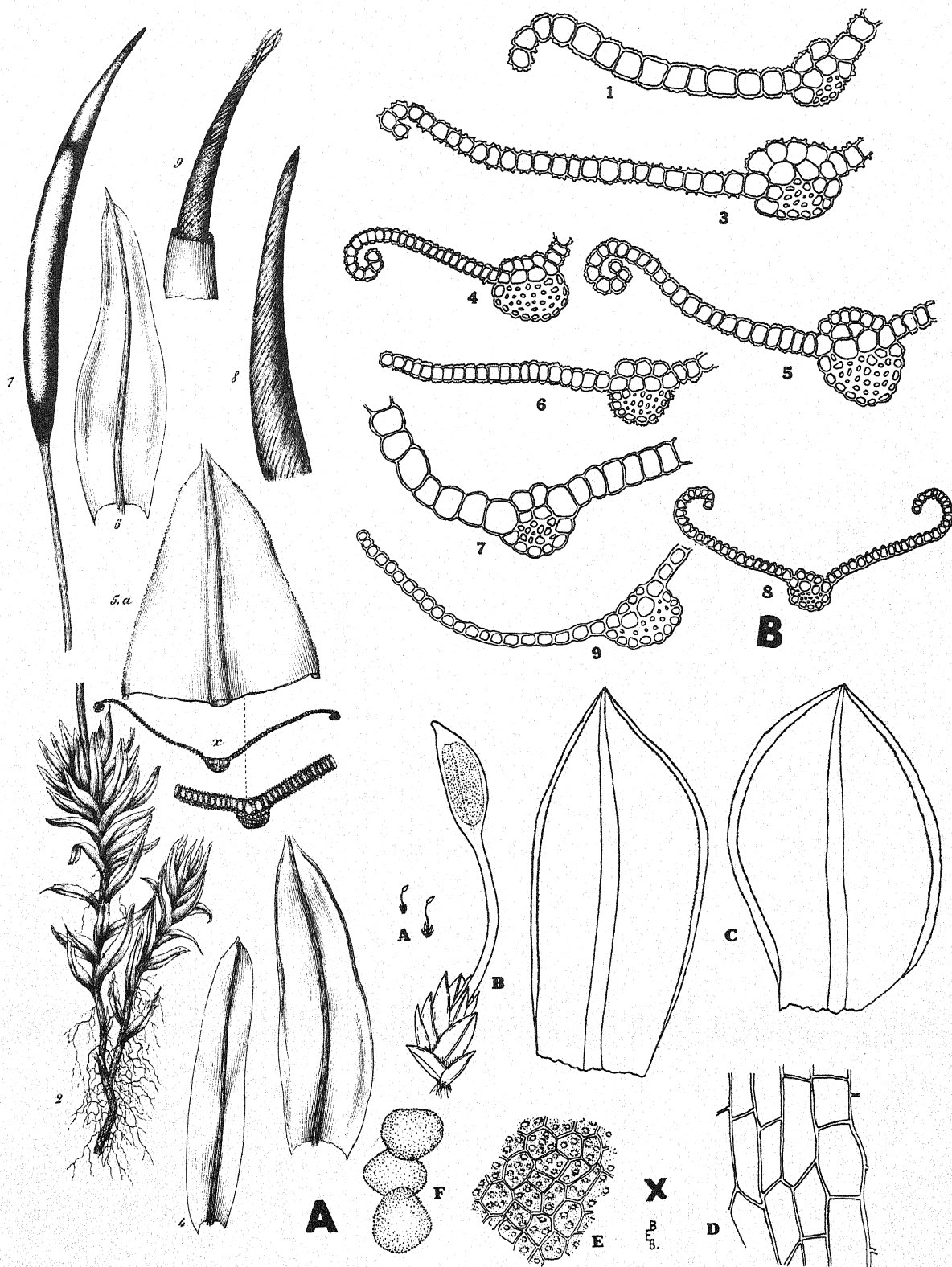


PLATE CIII

PLATE 104. *Desmatodon latifolius* (from Bry. Eur. *pl.* 129). 1, 3, plants $\times 1$; 1b, plant enlarged; 4-7, leaves; 7a, 8, apical leaf cells; 7b, basal cells; 7x, cross sections of leaf; 9, apex of perigonal leaf; 15-19, capsules; 20, 21, 22, peristome teeth; 23, annulus cells.

Lower left, 6-9, leaves of var. *muticus* (from Bry. Eur. *pl.* 130).

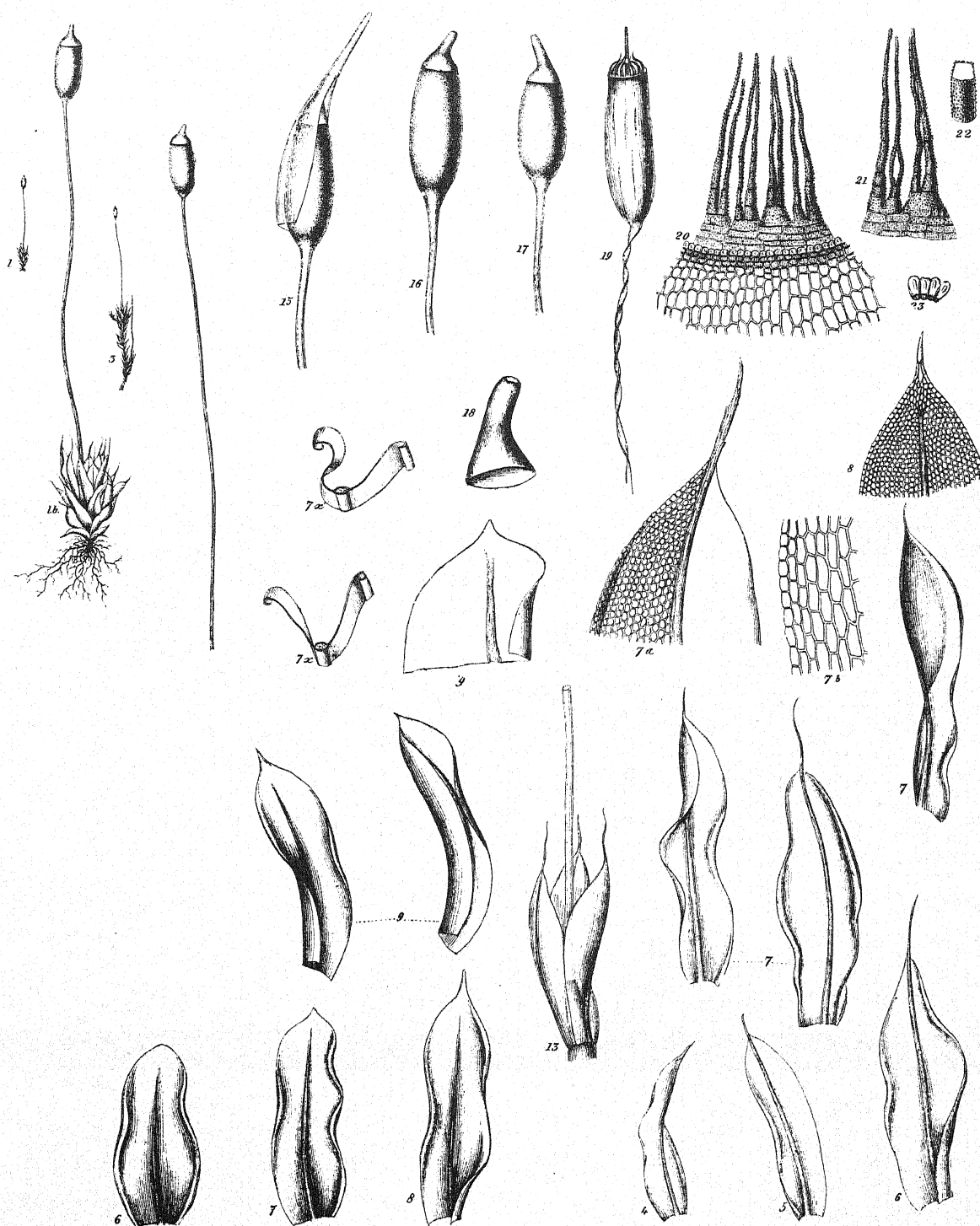
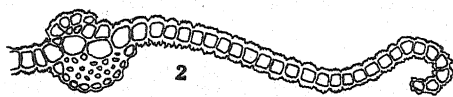


PLATE CIV

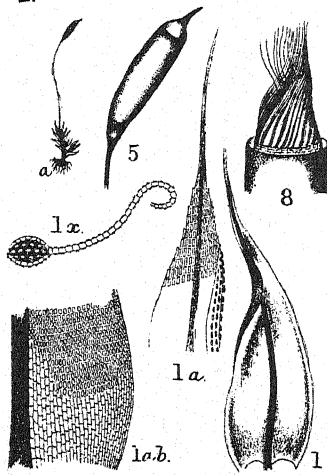
PLATE 105. *B. Desmatodon convolutus*. (*Tortula atrovirens*) (From Braithw. Brit. Moss. Fl. 1: pl. 31B). a, plant $\times 1$; i, leaf much enlarged; iaa, apex of leaf more enlarged; ix, cross section of leaf, structure of costa not shown; 4, paraphysis, antheridium, perigonal leaf; 5, capsule; 8, peristome.

C. Desmatodon Hendersoni (From Bot. Gaz. 15: pl. 5C). a, entire plant; b, lower leaf; c, c, lower leaves; d, d, d, points of the same; e, basal marginal cells; f, upper leaf cells; g, perichaetial leaf; h, capsule; i, exothelial cells; i*, i*, exothelial cells of *Didymodon trifarius*.

E. Desmatodon suberectus (From Braithw. l. c. pl. 41E, except f. 2 from Bull. Torr. Club. 46: pl. 11). a, plant $\times 1$; i, leaf much enlarged; ia, leaf apex; iab, leaf base; ix, cross section of leaf, cross section of costa inaccurate; 2, cross section of leaf $\times 270$; 5, capsule; 8, peristome.

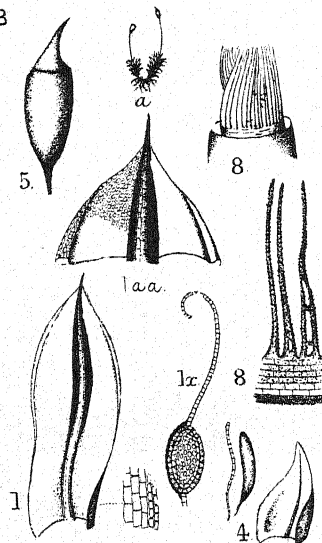


E.



Tort. suberecta.

B



Tort. atrovirens

C

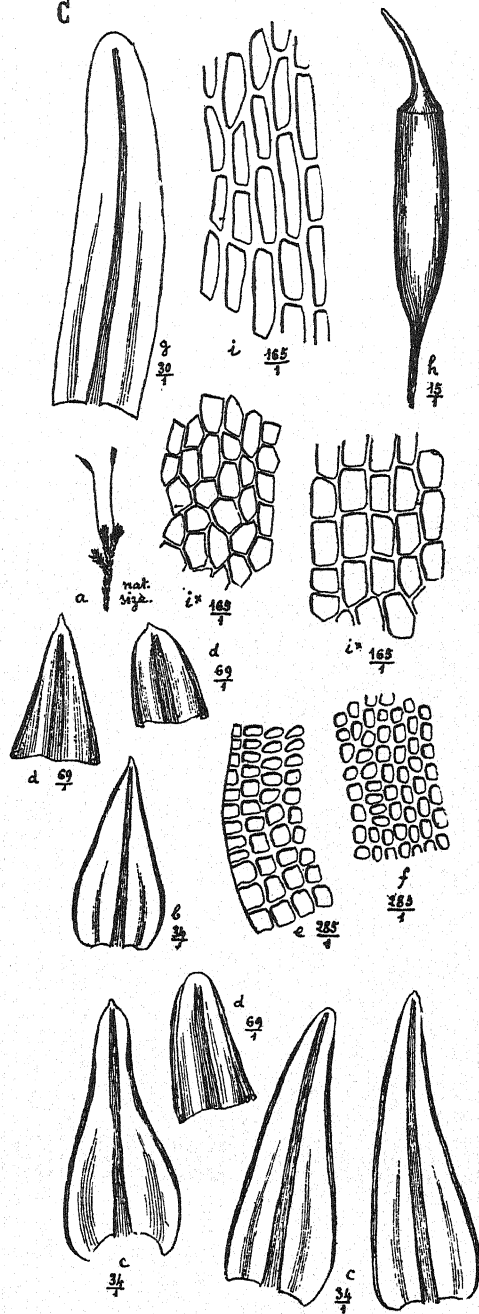


PLATE 106. Left, *Desmatodon Guepinii* (from Bry. Eur. *pl.* 133). 3, 4, leaves; 4a, cells at leaf apex; 4b, cells at leaf base; 4x, cross section of leaf; 6, antheridial bud; 7, perigonal leaves; 9, antheridia; 10, 11, 12, capsules showing calyptra, operculum and peristome respectively; 13, 14, peristome; 15, annulus cells; 16, spores.

Right, *Desmatodon systilius* (from Bry. Eur. *pl.* 131). 3-6, leaves; 9-12, upper and perichaetial leaves; 5a, apex of leaf; 7, antheridial bud; 8, archegonium antheridia and paraphyses; 14, capsule; 15, portion of peristome and annulus.

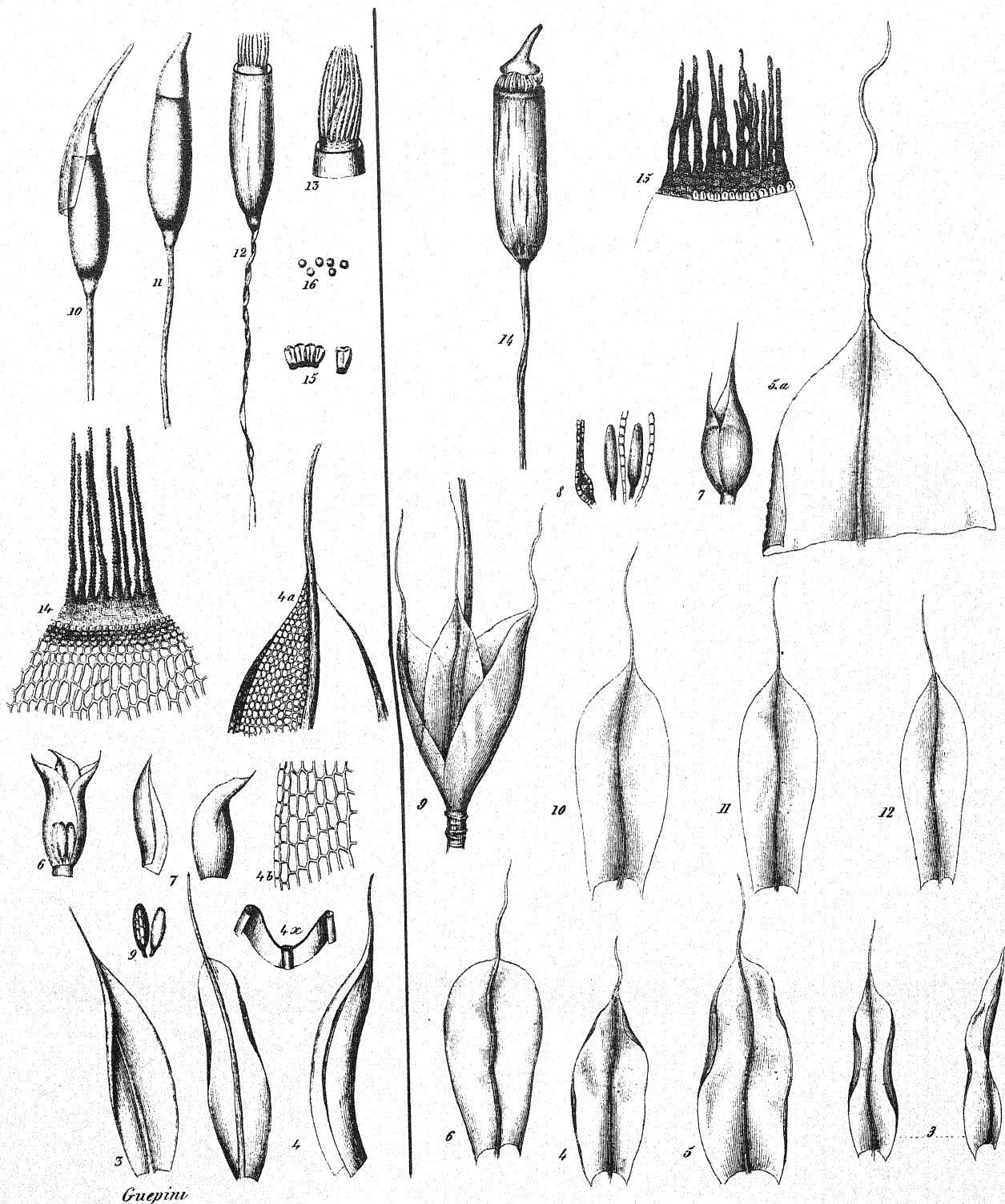


PLATE CVI

PLATE 107. Left, *Desmatodon Laureri* (from Bry. Eur. *pl.* 135). 4, 5, leaves; 5a, apex of leaf with excurrent costa; 4a, apical leaf cells; 4b, basal cells; 10, capsule showing arcuate seta, calyptra and operculum; 12, 13, peristome; 14, portion of annulus.

Right, *Desmatodon cernuus* (from Bry. Eur. *pl.* 134). 4, 5, 11, leaves; 4x, cross sections of leaf; 4a, apical leaf cells; 4b, basal cells; 11a, leaf apex; 12, 13, 14, capsules; 15-18, peristome; 19, annulus cells.

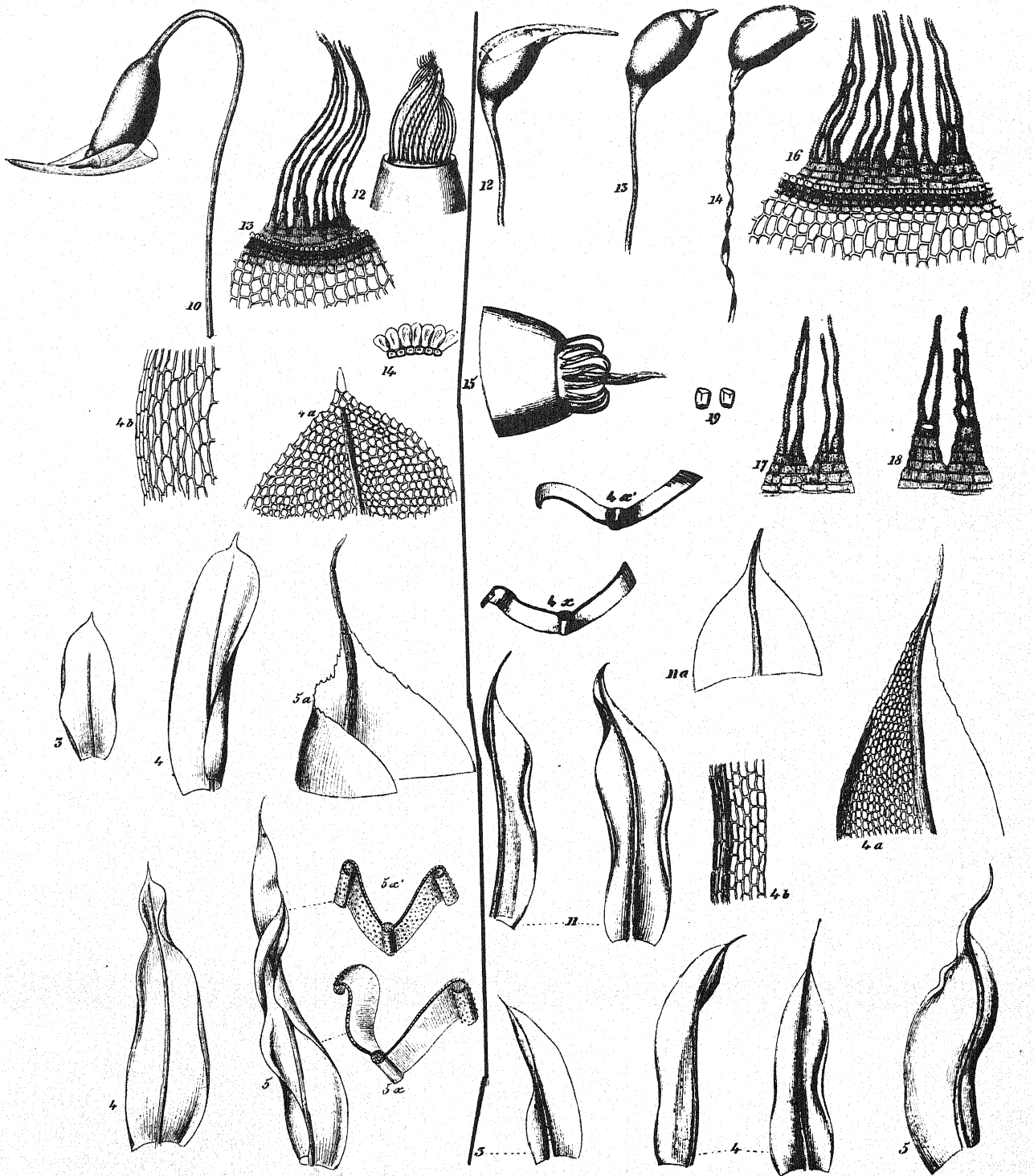


PLATE CVII

PLATE 108. A. *Desmatodon coloradensis*. 1, plant $\times 5$; 2, upper leaves $\times 30$; 3, middle leaves $\times 30$; 4, lower leaves $\times 30$; 5, leaf apex $\times 300$; 6, lower leaf cells $\times 600$; 7, median marginal leaf cells $\times 600$; 8, capsules $\times 20$; 9, mouth of capsule showing portion of annulus and peristome $\times 75$.

B. *Desmatodon Sprengelii*. 1, moist fruiting plant $\times 5$; 2, dry sterile plant $\times 5$; 3, leaves $\times 30$; 4, perichaetial leaf $\times 30$; 5, serrate leaf apices $\times 75$; 6, cross sections of leaf $\times 300$; 7, basal leaf cells $\times 300$; 8, median cells $\times 300$; 9, portion of peristome $\times 300$; 10, capsule $\times 20$. (Drawings by Seville Flowers.)

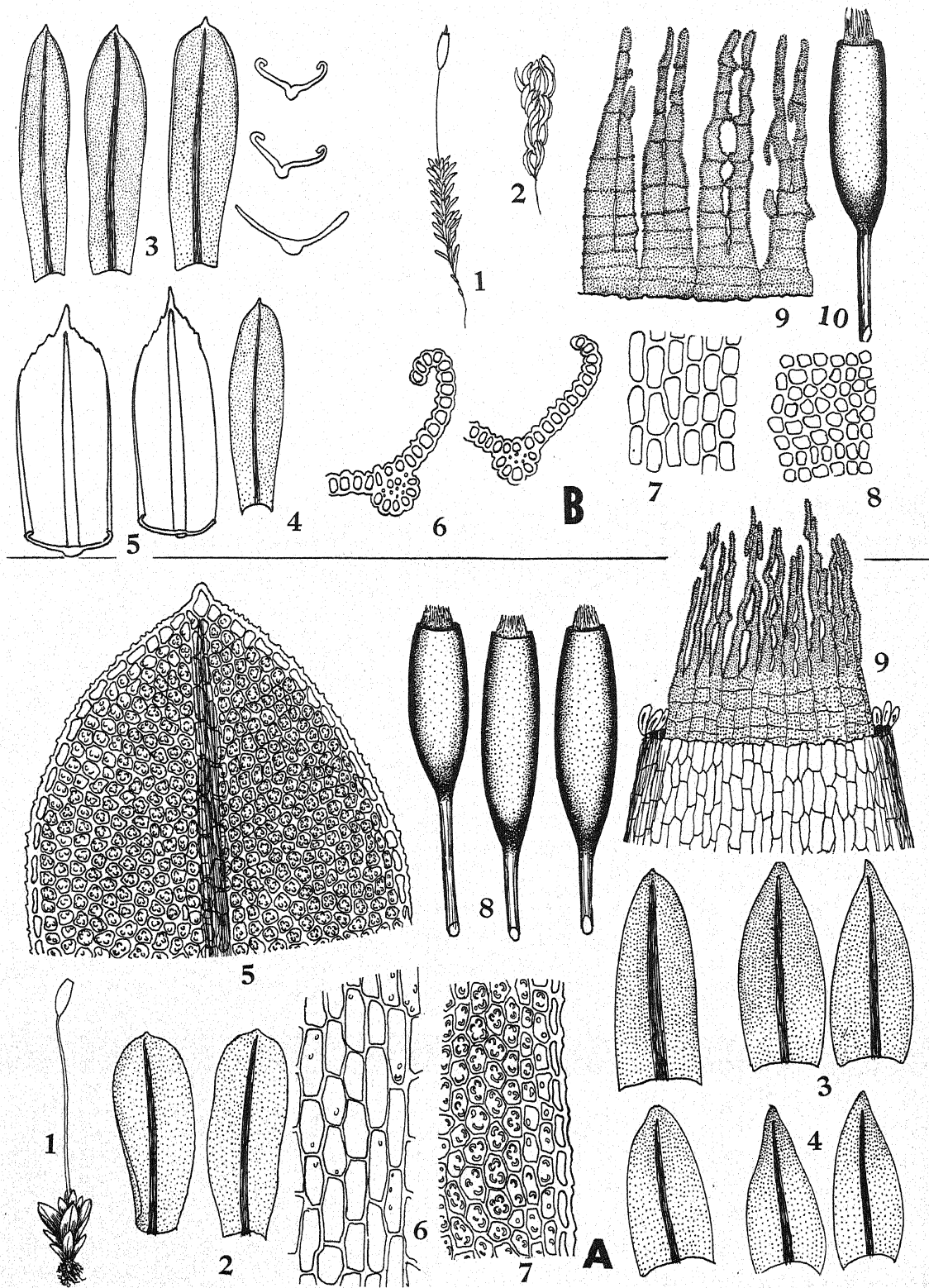


PLATE CVIII

PLATE 109. *A. Trichostomopsis brevifolia* Bartram. a-b, dry plants $\times 1\frac{1}{2}$; c, moist plant $\times 4$; d-e, stem leaves $\times 24$; f, inner perichaetial leaf $\times 24$; g, apex of stem leaf $\times 60$; h, upper leaf cells $\times 360$; i, basal cells $\times 360$; k, two cross-sections from upper leaf margin $\times 360$; l, cross-section of costa about mid-leaf $\times 360$; m, capsule $\times 9$; n, part of peristome $\times 120$; o, part of peristome fork $\times 700$; p, lid $\times 24$.

B. Bryobrittonia pellucida. 1, plant $\times 1$; 2, upper stem leaf $\times 8$; 3, lower stem leaf $\times 8$; 4, cross section of leaf $\times 160$; 5, cross section of stem $\times 160$, a, section of costa at point where it joins stem, b, base of radicle, c, costa where it is adnate to the stem; 6, apex of leaf $\times 285$; 7, leaf cells at margin a little above the base $\times 285$; 8, cross section of upper costa $\times 160$.

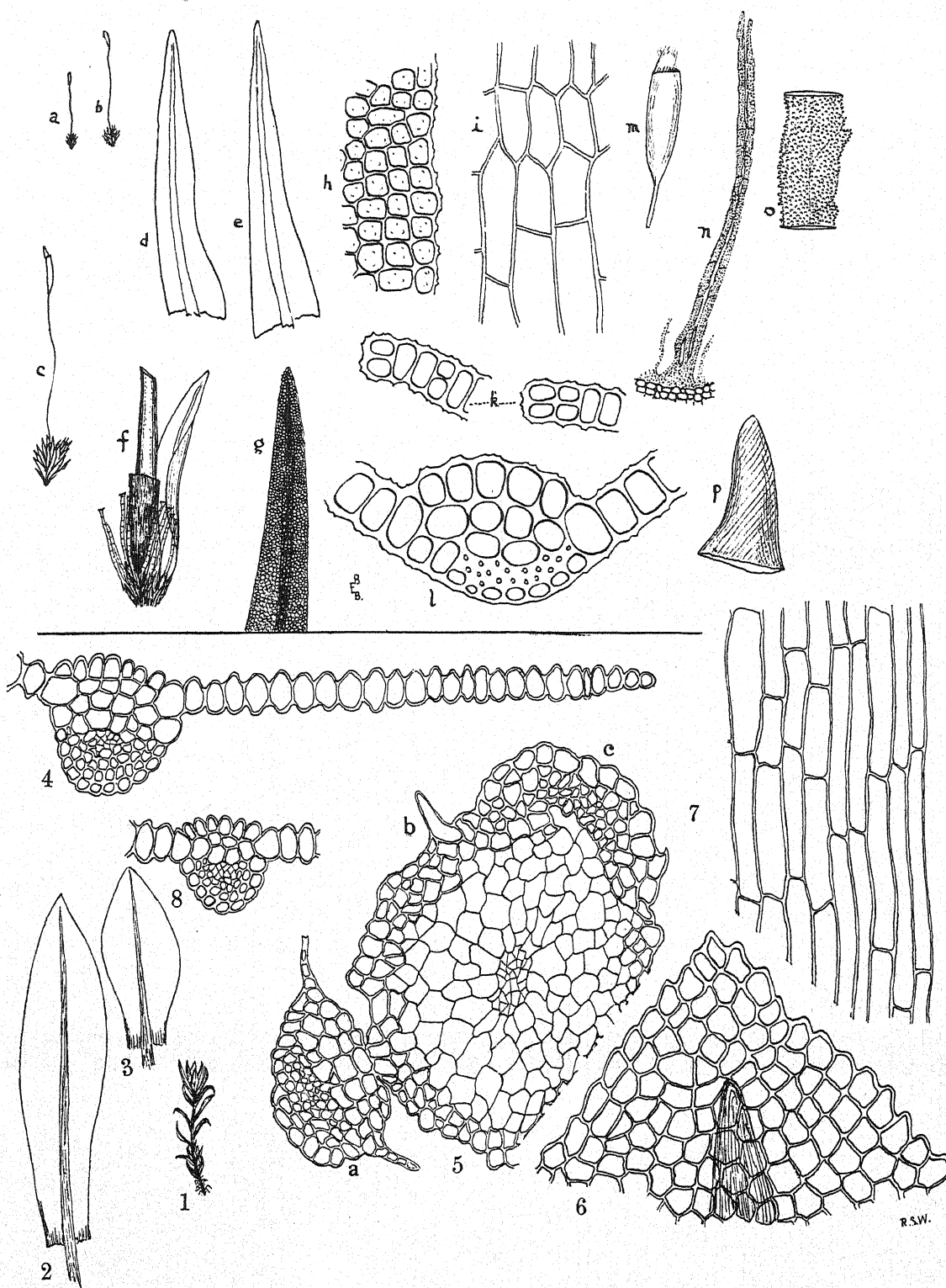


PLATE CIX

PLATE 110. A. *Trichostomopsis diaphanobasis*. 1, plants $\times 3$; 2, capsules $\times 13$; 3, peristome and annulus $\times 50$; 4, leaves from type collection $\times 20$; 5, from Orcutt's no. 7053 $\times 20$; 6, cross sections of leaf $\times 400$; 7, cross section of leaf near base $\times 400$; 8, leaf apices $\times 400$; 9, median marginal leaf cells $\times 400$; 10, basal cells $\times 400$.

B. *Trichostomopsis Fayae*. 1, plants $\times 3$; 2, leaves $\times 20$; 3, leaf sections $\times 400$; 4, basal leaf cells $\times 400$; 5, median marginal leaf cells $\times 400$; 6, leaf apex $\times 400$; 7, capsules $\times 13$; 8, peristome $\times 50$.

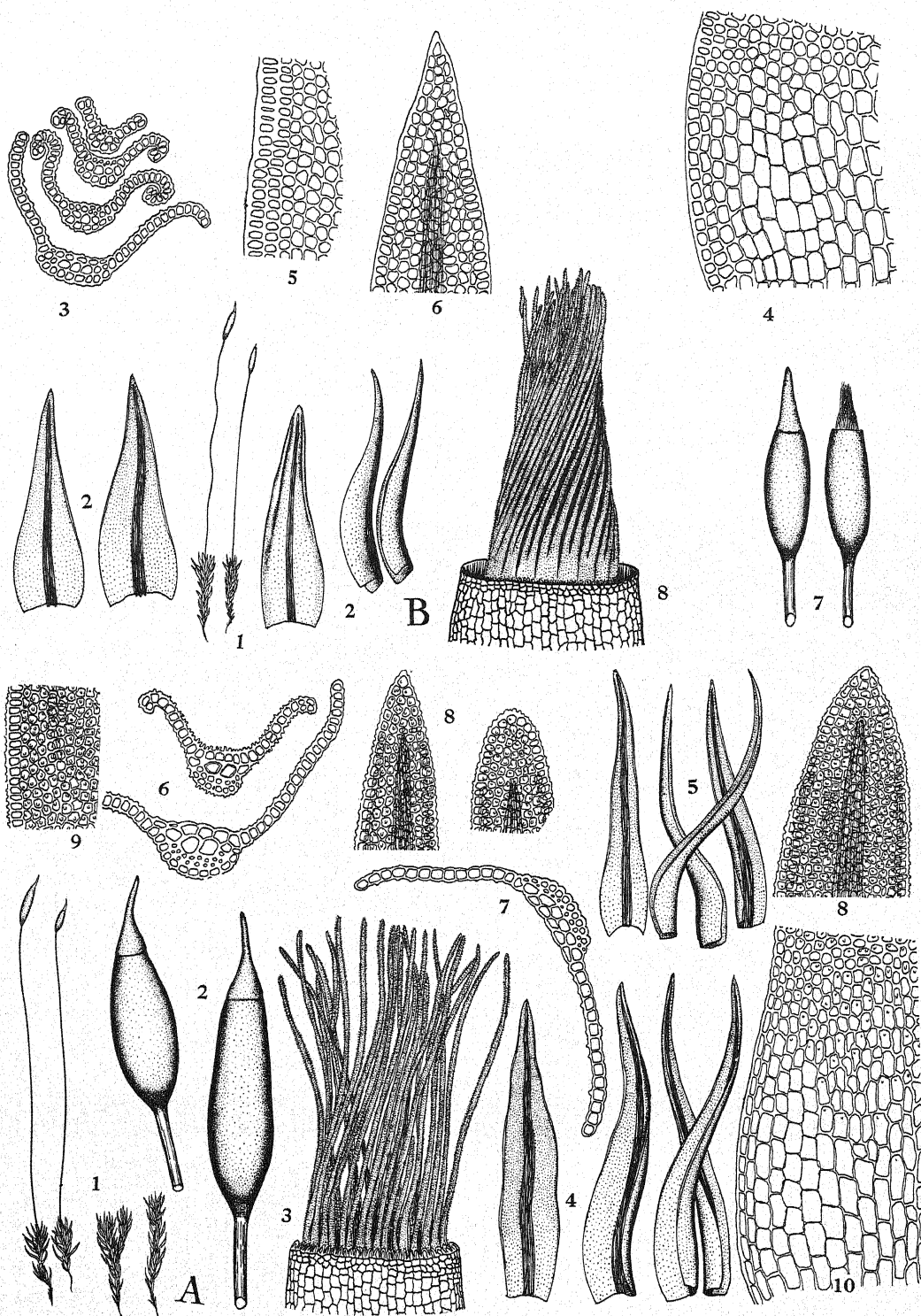


PLATE CX

PLATE III. A. *Tortula aurea* (From Bull. Torr. Club, 51: pl. 6). 1, 2, dry plants $\times 4/5$; 3, upper part of moist plant $\times 12$; 4, 5, stem leaves $\times 16$; 6, leaf apex $\times 40$; 7, leaf apex $\times 80$; 8, portion of leaf cross section $\times 240$; 9, upper leaf cells $\times 240$; 10, basal marginal cells $\times 240$; 11, basal cells next costa $\times 240$.

B. *Tortula fragilifolia* (From Bull. Torr. Club, 51: pl. 7). 1, moist plant $\times 4/5$; 2, moist plant $\times 4$; 3, 4, 5, 6, leaves $\times 16$; 7, propagula $\times 80$; 8, basal cells to left of costa $\times 80$; 9, portion of cross section of leaf from lower half $\times 240$; 10, cross section of costa from upper half of leaf; 11, upper leaf cells $\times 480$.

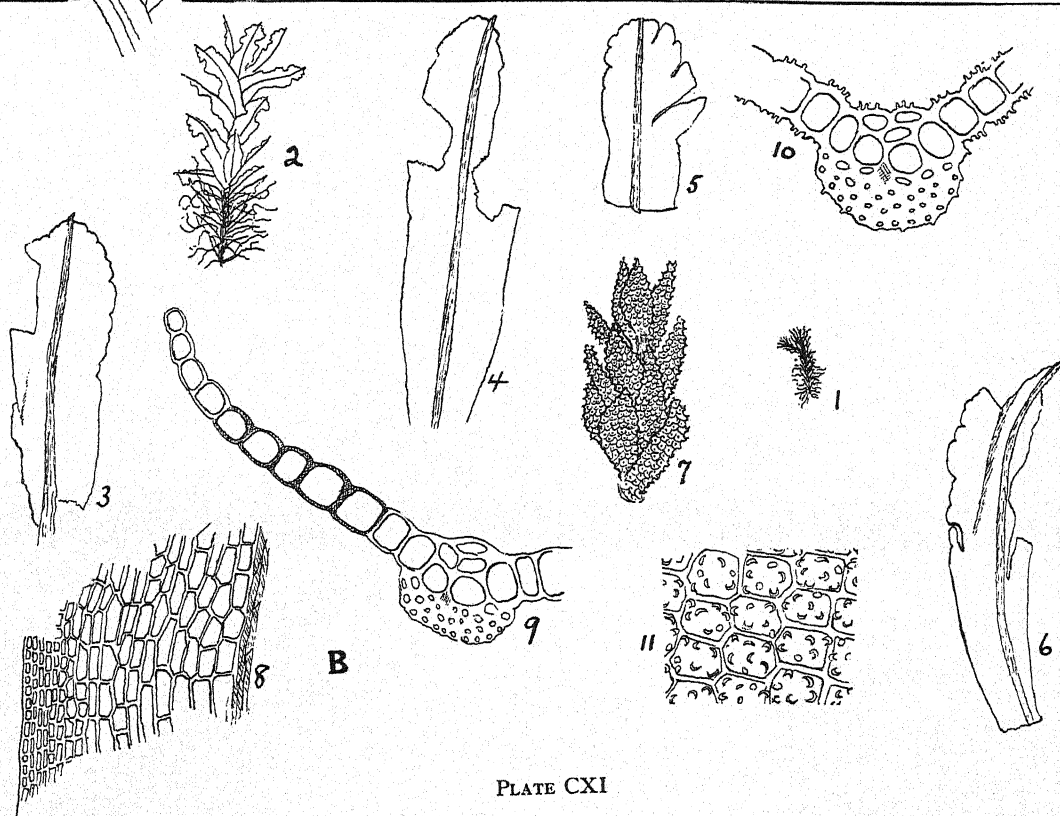
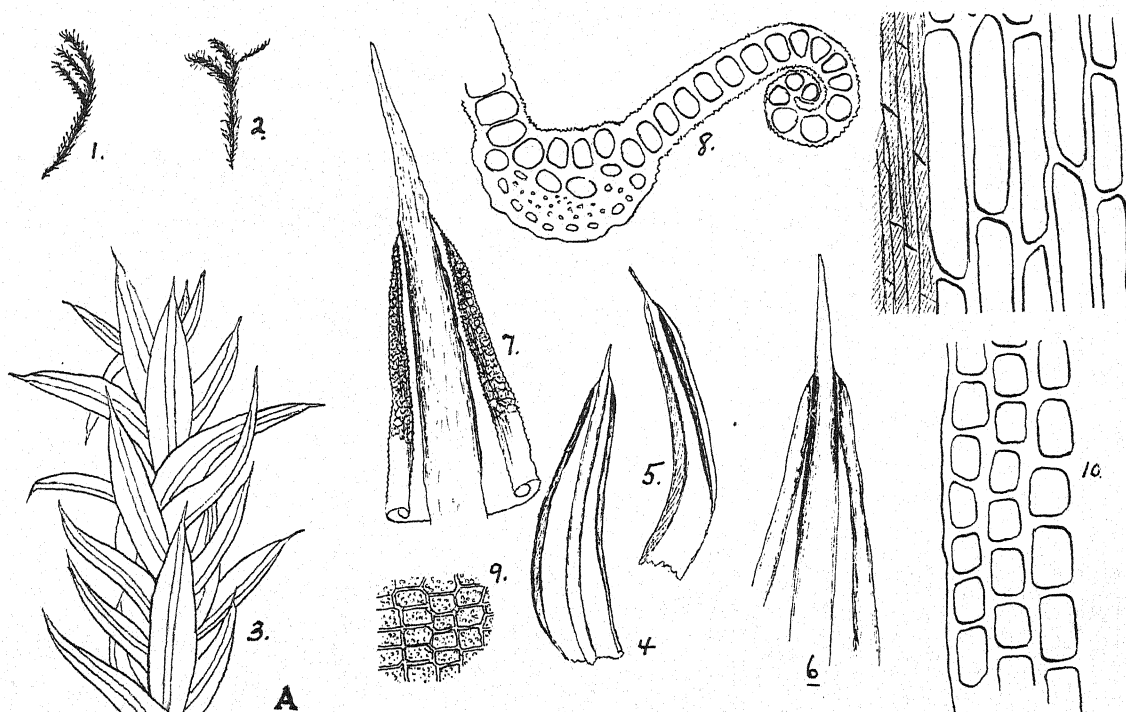


PLATE CXI

PLATE 112. A. *Tortula brevipes*. B. *Tortula amplexa*. C. *Tortula Bolanderi*. This plate was very kindly prepared by Miss Olivia Embrey from original pencil sketches by W. S. Sullivan, now at the Farlow Herbarium of Harvard University. The figures are self-explanatory.



PLATE CXII

PLATE 113. *A. Tortula Williamii* (From Bryol. 27: pl. 11). 1, 2, plants about $\times 1$; 3, moist plant $\times 5$; 4, cross section of costa from lower half of leaf; 5, 6, stem leaves $\times 20$; 7, cross section of leaf $\times 50$; 8, cross section of part of upper leaf $\times 300$; 9, leaf apex $\times 300$; 10, one side of leaf base $\times 100$.

*B. Tortula caroliniana** (From Bryol. 23: pl. 5). 1, dry plant $\times 1.6$; 2, dry plant $\times 3$; 3, moist plant $\times 10$; 4, leaf $\times 32$; 5, section of costa $\times 288$; 6, leaf apex $\times 160$; 7, right side of leaf base $\times 160$; 8, upper leaf cells $\times 400$; 9, apex of leaf with propagula $\times 40$; 10, propagula $\times 96$.

* In the illustration the papillae are represented as too irregular in shape and somewhat too large. Their shape is that of a perfectly regular crescent, except as they sometimes form a complete, but again perfectly regular ring. This last tendency is stronger on the dorsal surface and also increases with exposure of the plants to light and sun.

In the illustration they are slightly flattened down by the cover-glass; when undisturbed the propagula rise exactly perpendicular to the leaf-surface and are not at all confined to the immediate apex of the leaf. The costa is represented as too broad in the figure.

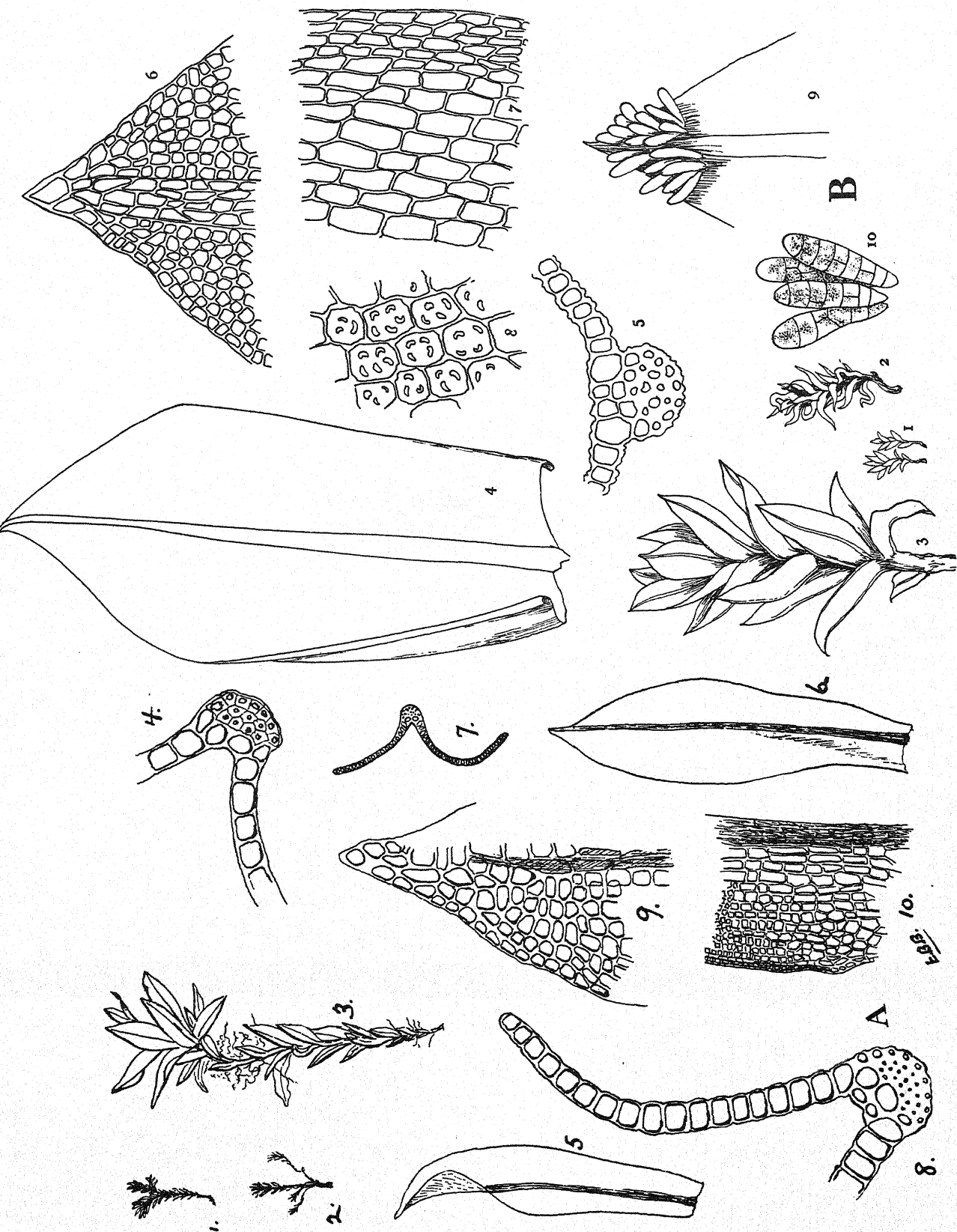


PLATE 114. *Tortula pagorum* (photograph by A. T. Beals). 1, plant $\times 80$; 2, cells at upper edge of leaf $\times 450$; 3, base of leaf $\times 120$; 4, propagula $\times 60$.

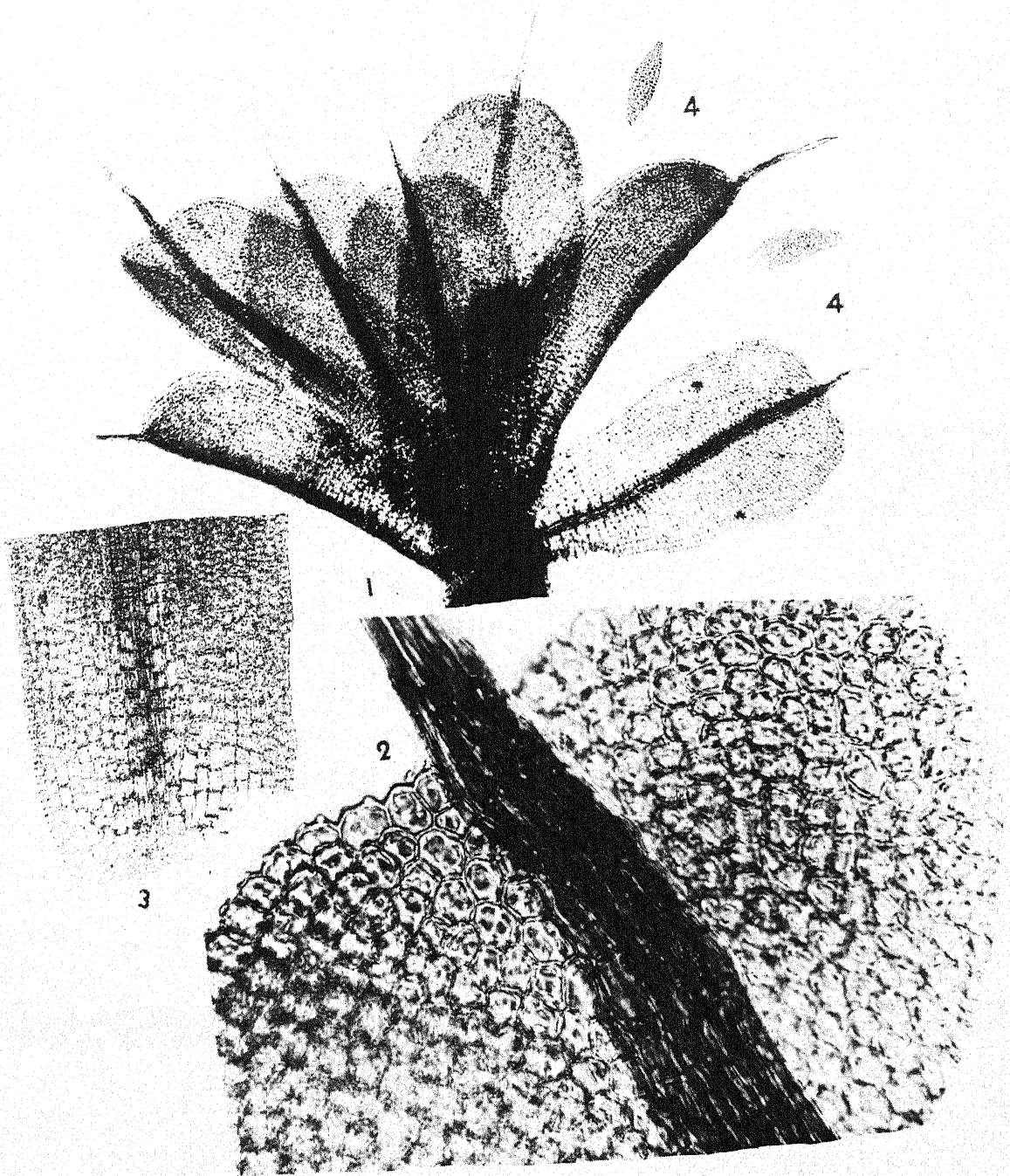


PLATE CXIV

PLATE 115. *A. Tortula obtusissima*. 1, Fertile plant $\times 7$; 2, individual leaves $\times 17$; 3-5, sections from progressively higher levels of a leaf $\times 67$; 6, detail of areolation of upper part of leaf $\times 533$.

B. Tortula Bartramii. 1, whole sterile plant $\times 20$; 2-5, individual leaves $\times 23$; 6, sections of upper part of leaf $\times 67$; 7, section of leaf to show papillae $\times 667$; 8, detailed areolation of upper part of leaf $\times 533$.

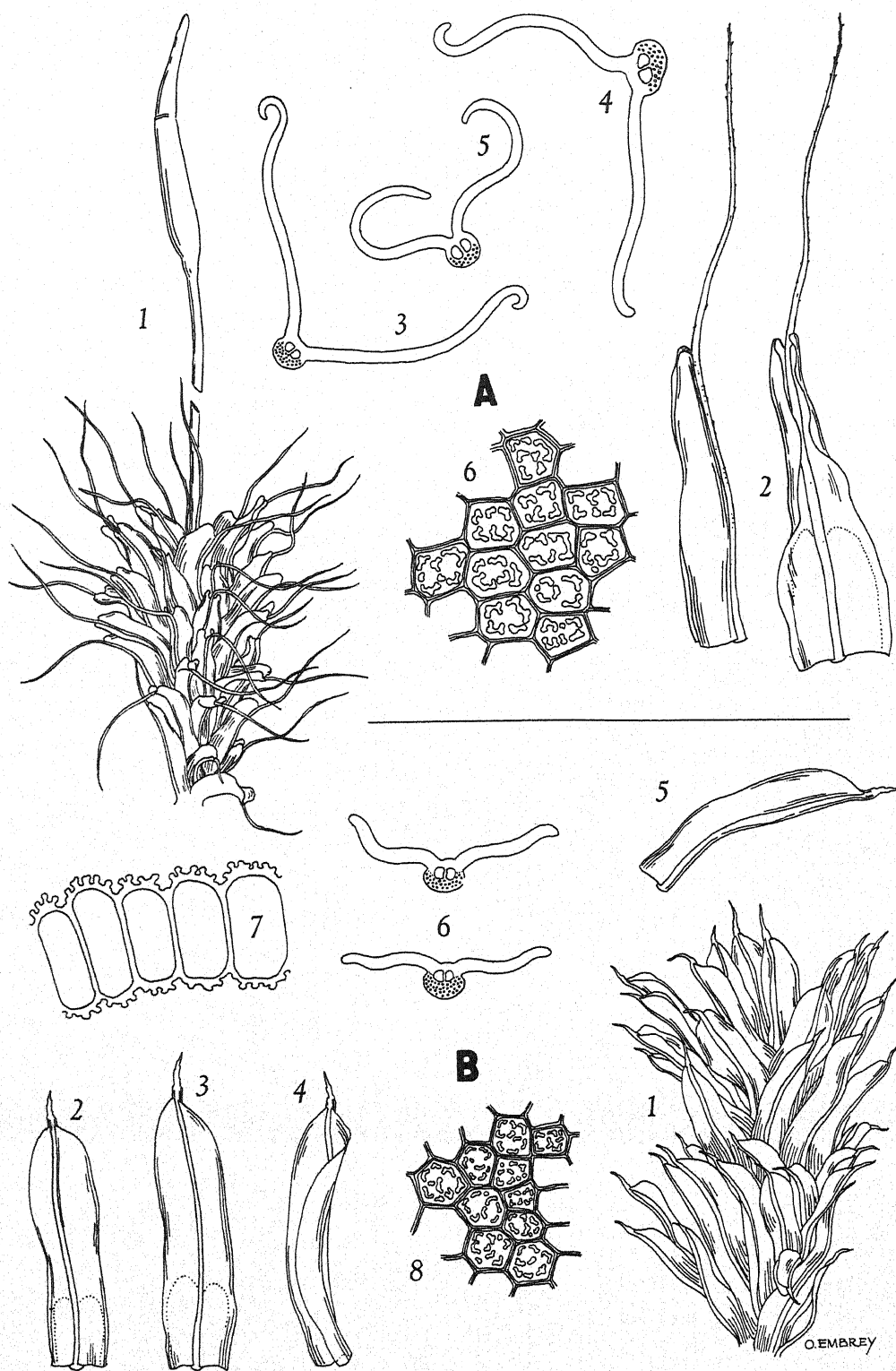


PLATE CXV

PLATE 116. A. *Tortula propagulosa* (from Bryologist 36: pl. 1). 1, plant $\times 25$; 2, dorsal view of leaf $\times 25$; 3, apical leaf cells $\times 200$; 4, dorsal view of a portion of leaf base with propagula $\times 200$; 5, cross section of costa $\times 200$.

B. *Tortula ruraliformis*. 1, leaf; 1a, leaf apex; 1c, upper leaf cells.

C. *Tortula princeps* (from Braithw. Brit. Moss Fl. 1: pl. 33C). a, plant $\times 1$; 1, leaf; 1x, cross section of leaf; 3, antheridia at base of seta; 7, peristome.

D. *Tortula subulata*. 1, plant; 1, leaf; 1a, leaf apex; 1c, leaf cells; 1x, cross section of leaf margin; 6, peristome.

D'. *Tortula norvegica*. 1, leaf; 1a, leaf apex; 1c, upper median leaf cells.

E. *Tortula subulata* var. *angustifolia*. *, plant; 1, leaf; 1a, leaf apex; 1c, marginal leaf cells; 1x, cross section of leaf margin.

(B, D, D', E, from Dixon, Handb. Brit. Mosses Ed. 3; B & D' from pl. 26; D & E from pl. 25.)

Fig. 11, cross section of leaf of *Desmatodon cernuus* $\times 270$; fig. 12, cross section of leaf of *D. Laureri* $\times 270$. Both from Bull. Torr. Club. 46: pl. 11.

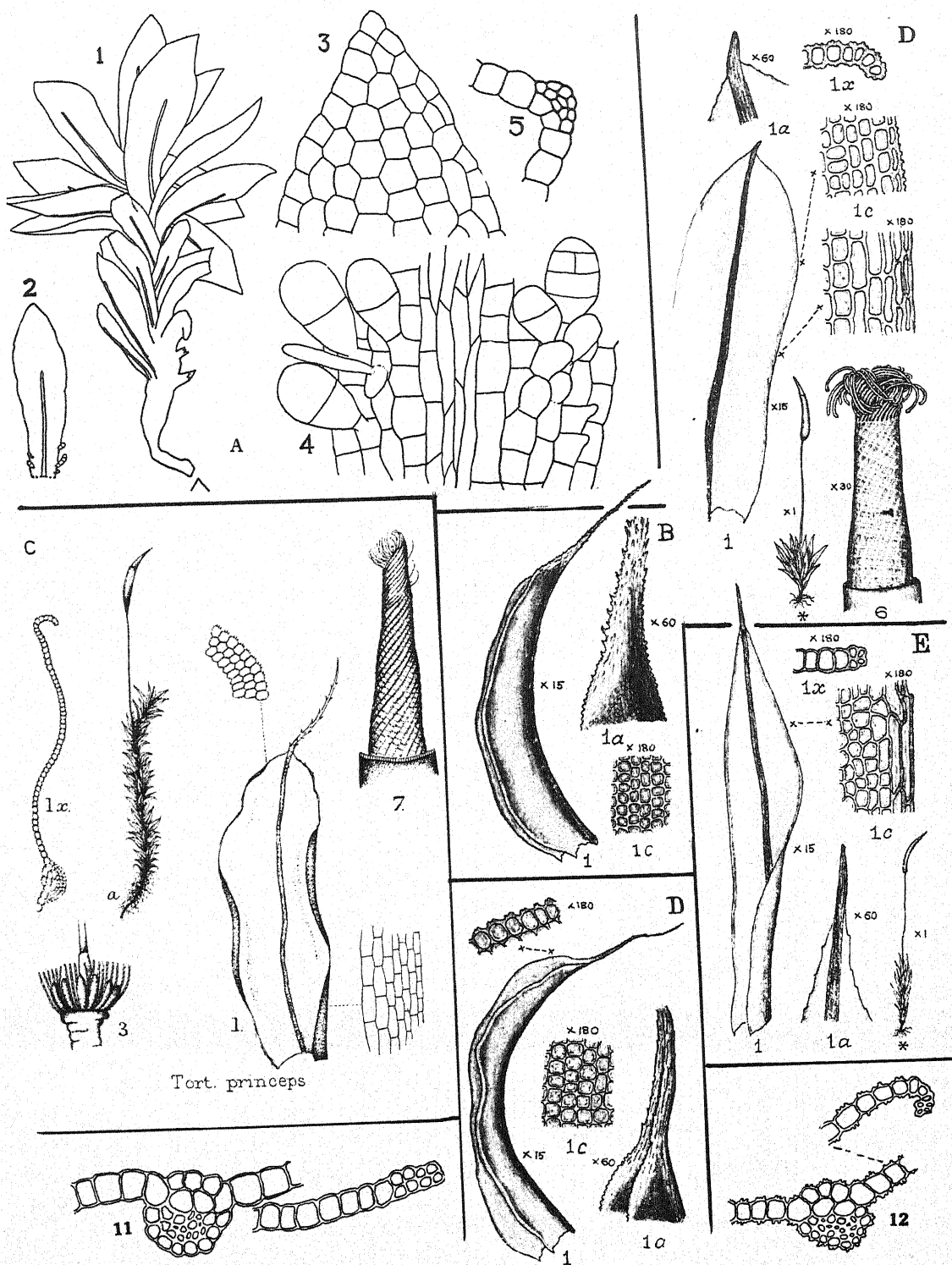


PLATE 117. Left, *Tortula latifolia* (from Bry. Eur. *pl.* 164). 1, 2, 3, plants $\times 1$; 1b, plant magnified; 4-7, leaves; 5x, cross section of leaf; 8, portion of stem with archegonia and base of seta; 9, capsule with calyptra; 10, annulus.

Right. *Tortula laevipila* (from Bry. Eur. *pl.* 164). 1, 2, 3, plants $\times 1$; 2b, plant enlarged; 3, 4, leaves; 4a, cells of leaf apex; 4x, cross sections of leaves; 5, portion of stem with male and female organs; 6, antheridial bud; 7, antheridia and paraphyses; 8, capsule with calyptra; 9, peristome; 10, cells of annulus.

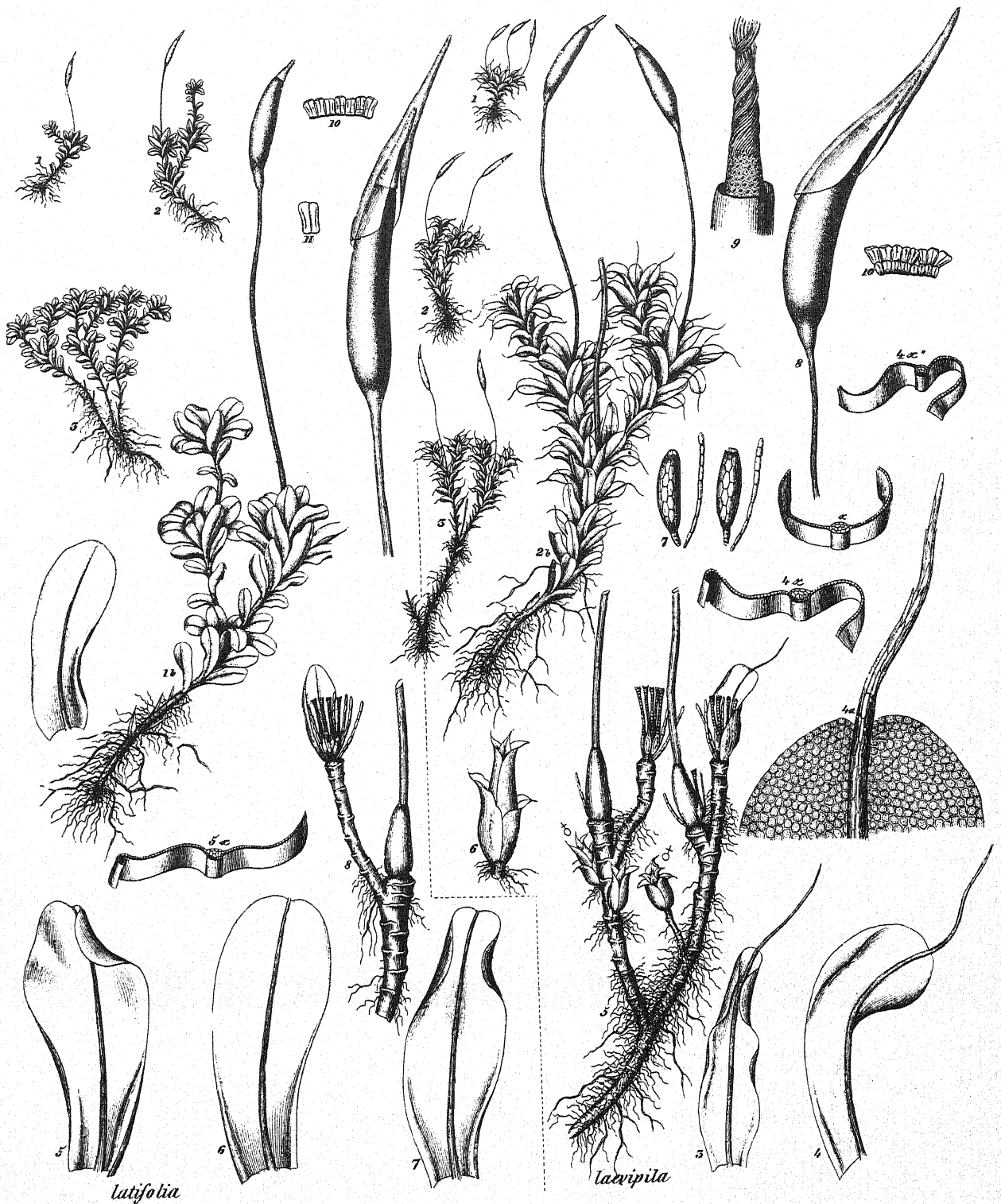


PLATE CXVII

PLATE 118. *Tortula intermedia* (from DeNot. Musci Ital. plate 15). 1, 2, leaves $\times 20$; 3, 4, cross sections of leaf $\times 20$; 5, basal leaf cells $\times 400$; 6, upper leaf cells $\times 400$; 7, portion of leaf awn $\times 400$; 8, 9, capsules $\times 20$; 10, calyptra $\times 20$; 11, cells of annulus $\times 100$; 12, spores $\times 400$.

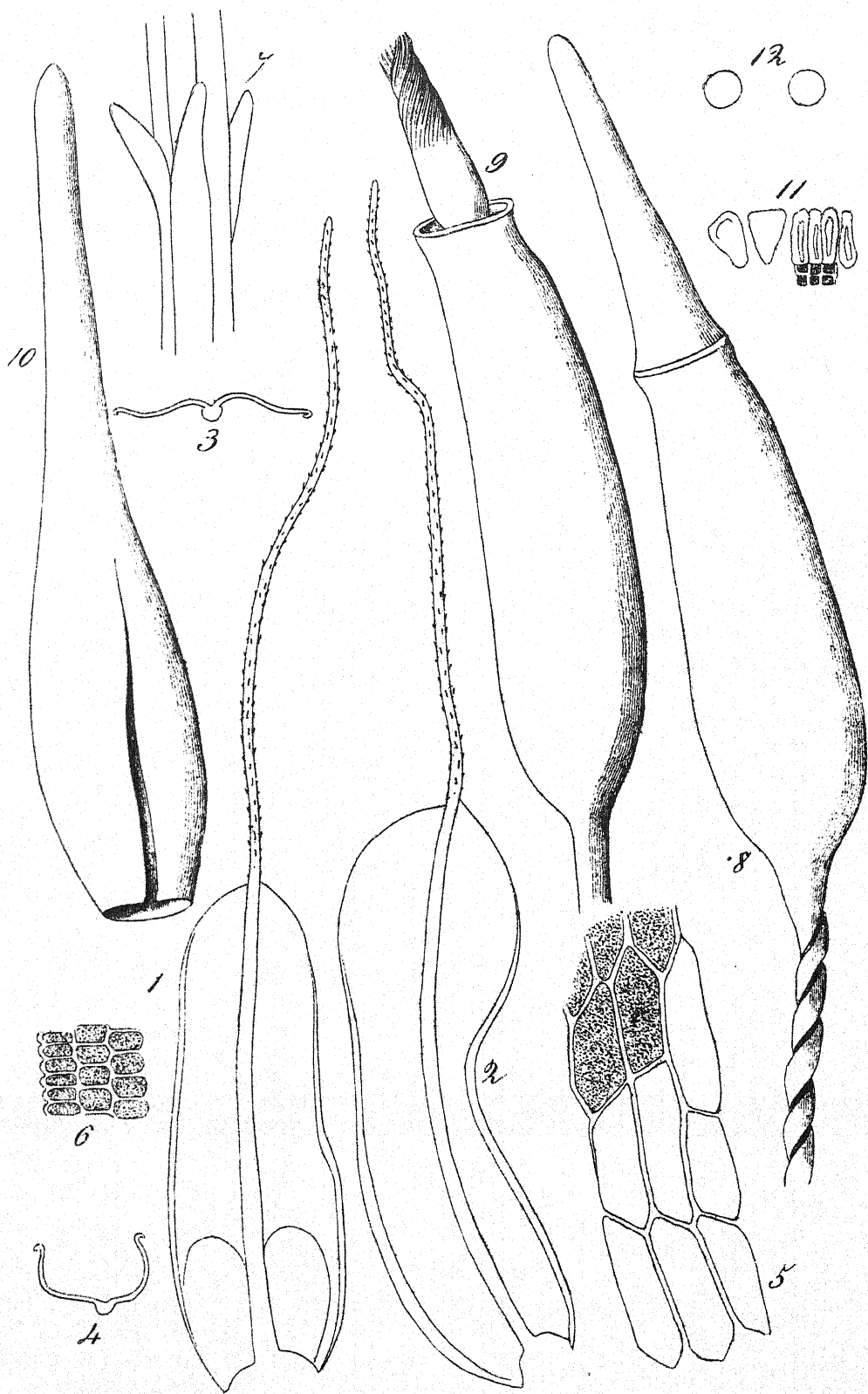


PLATE CXVIII

PLATE 119. A. *Husnotiella Pringlei*. 1, plants $\times 5$; 2, leaves $\times 30$; 3, perichaetial leaves $\times 30$; 4, perichaetium and base of seta $\times 30$; 5, leaf apex $\times 600$; 6, capsules $\times 20$; 7, mouth of capsule $\times 100$. (Cardot in his original description says costa is percurrent or subpercurrent but Flowers' drawings represent the condition in the Arizona plants.)

B. *Husnotiella torquescens*. 1, leaves $\times 30$; 2, leaf apices $\times 600$; 3, basal leaf cells $\times 600$.

C. *Husnotiella revoluta*. 1, leaves $\times 30$; 2, leaf apex $\times 600$; 3, leaves of var. *Palmeri* $\times 30$. (Drawings by Seville Flowers.)

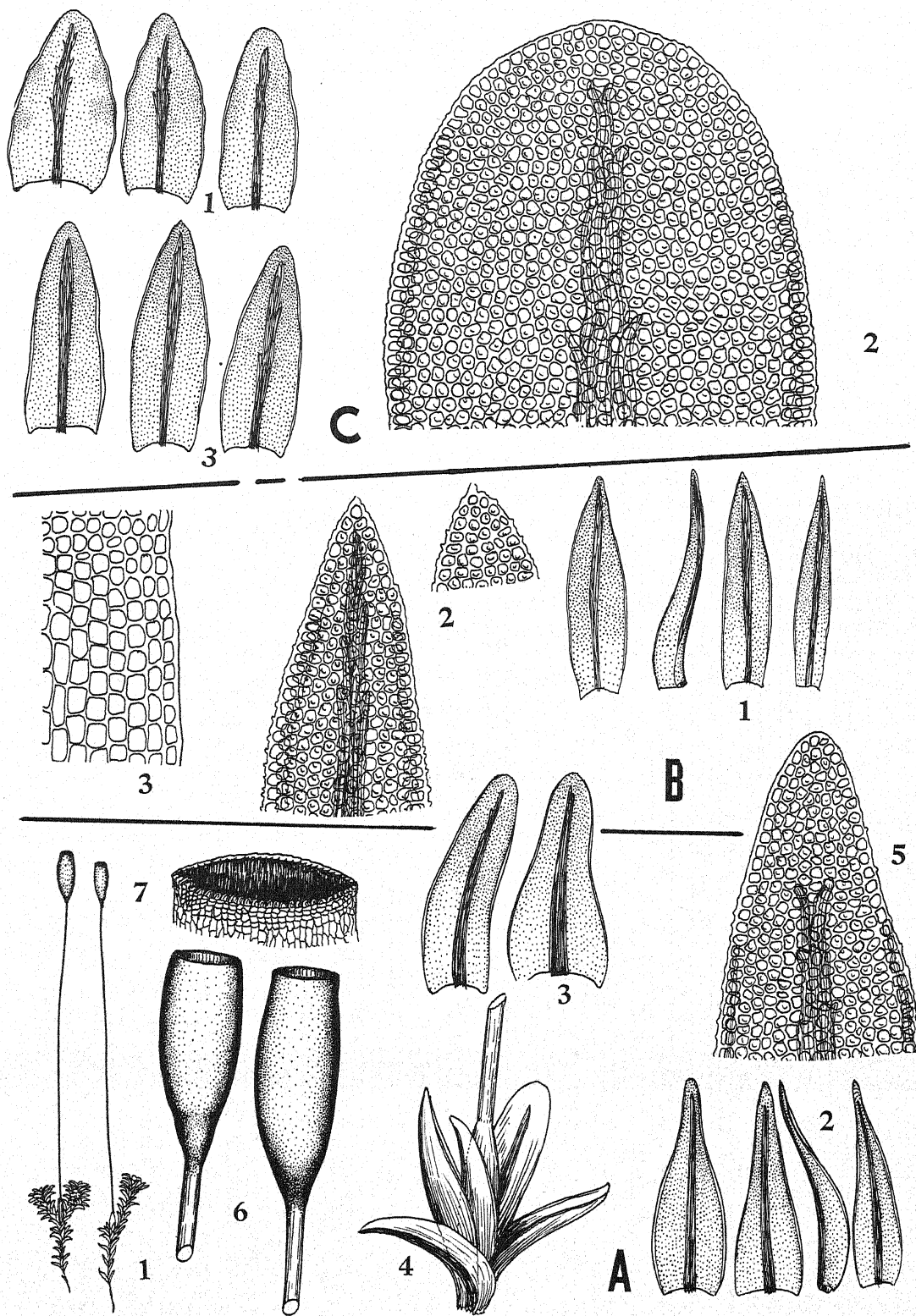


PLATE CXIX

PLATE 120. A. 1-5, *Merceya ligulata*, 1, habit sketch $\times 1$; 2, leaves $\times 20$; 3, cross sections of leaves $\times 300$; 4, upper median and marginal cells $\times 300$; 5, basal median and marginal cells $\times 300$; var. *Bartramii* 6-9, 6, leaves $\times 20$; 7, cross section of leaf $\times 300$; 8, upper median cells $\times 300$; 9, basal median cells $\times 300$.

B. *Merceya latifolia*. 1, habit sketch $\times 1$; 2, leaves $\times 20$; 3, cross sections of leaf $\times 150$; 4, two cross sections of leaf margins $\times 300$; 5, upper median and marginal cells $\times 300$; 6, basal median and marginal cells $\times 300$; 7, cross section of stem $\times 150$.



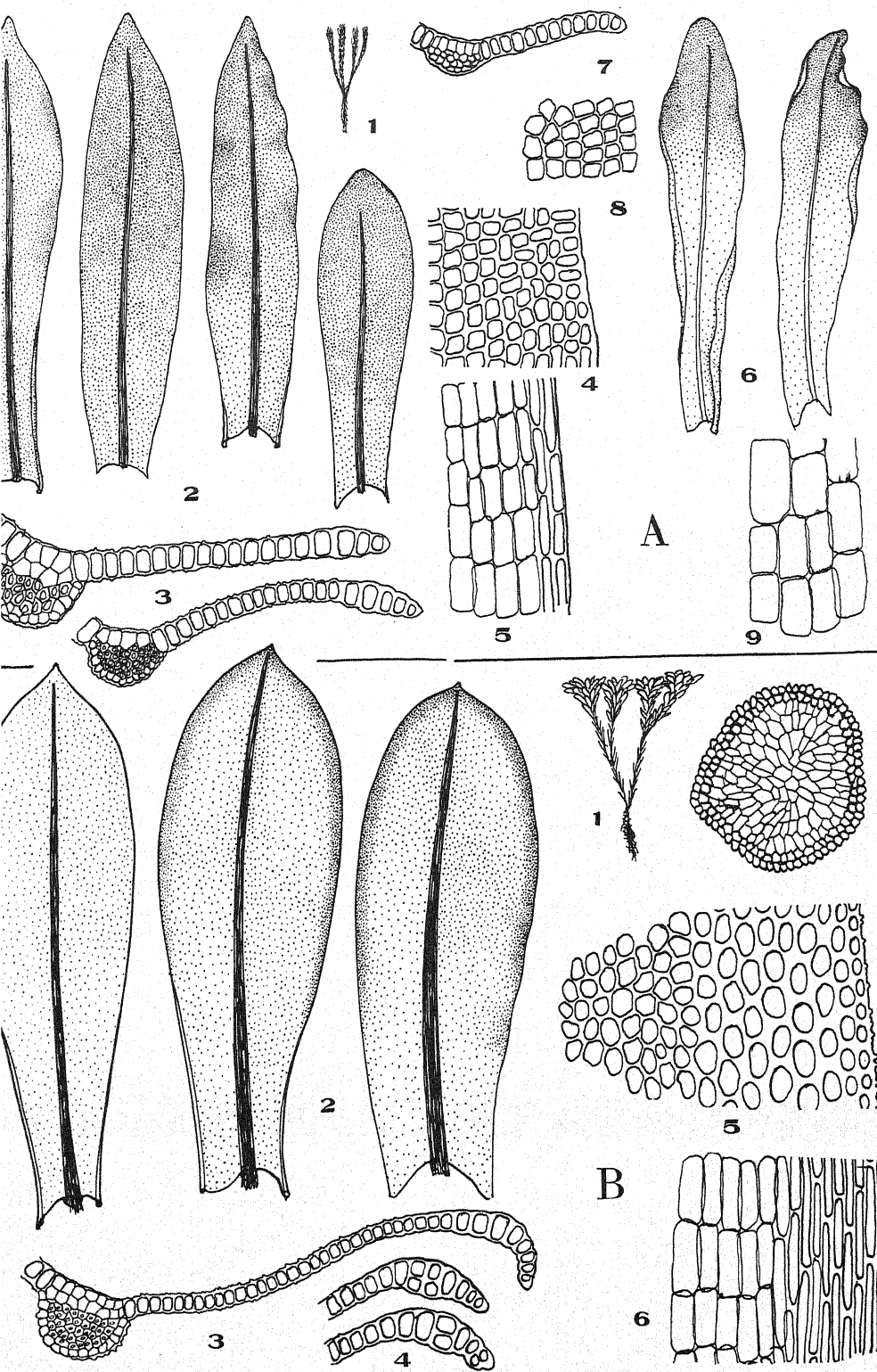
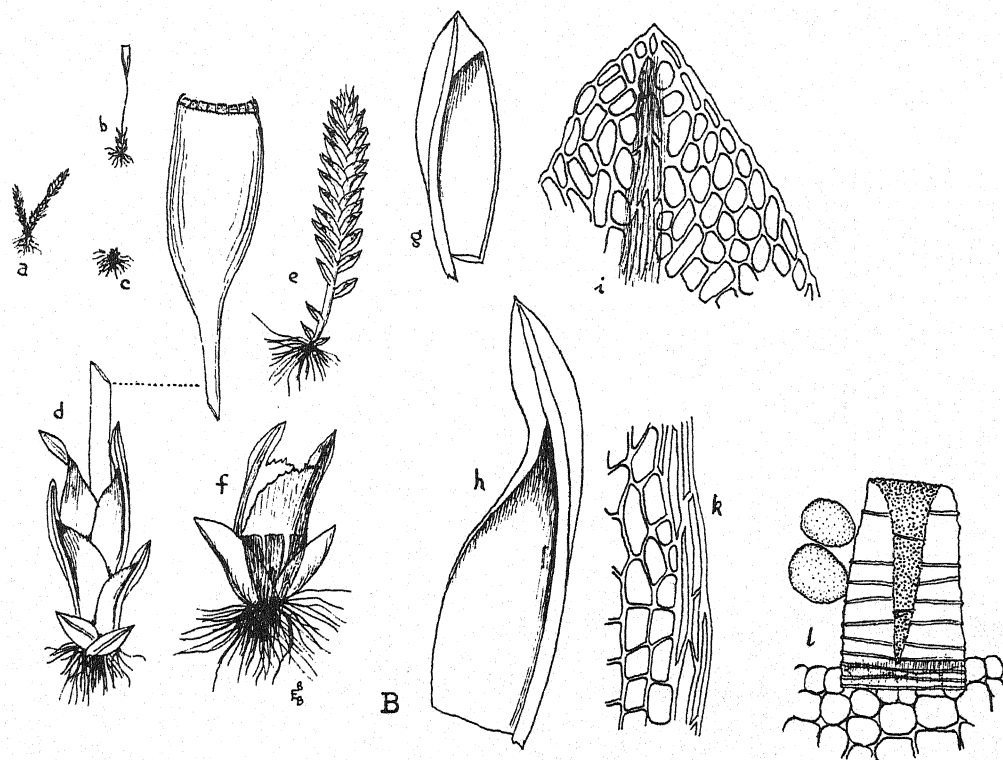


PLATE CXX

PLATE 121. A. *Syrrhopodon Gaudichaudi* (drawings by Dr. Flowers). 1, leaves from a Florida plant $\times 20$; 2, leaves from a Brazilian plant $\times 20$; 3, leaf apex of Florida plant $\times 200$; 4, leaf apex of a Brazilian plant $\times 200$; 5, leaf apex of Florida plant bearing brood bodies $\times 200$; 6, leaf apex of Brazilian plant with brood bodies $\times 200$; 7, upper marginal leaf cells $\times 200$.

B. *Fissidens Neoni* (from Bryol. 34: pl. 5). a, sterile branched stem $\times 3$; b, fertile plant $\times 3$; c, male plant $\times 3$; d, fertile plant $\times 25$; e, sterile stem $\times 8.7$; f, male plant $\times 60$; g, stem leaf $\times 60$; h, perichaetial leaf $\times 60$; i, apex of stem leaf $\times 350$; k, basal margin of vaginant lamina $\times 350$; l, peristome tooth from the inner side $\times 350$.



MOENKEMEYERA NEONI Bartram, sp. nov.

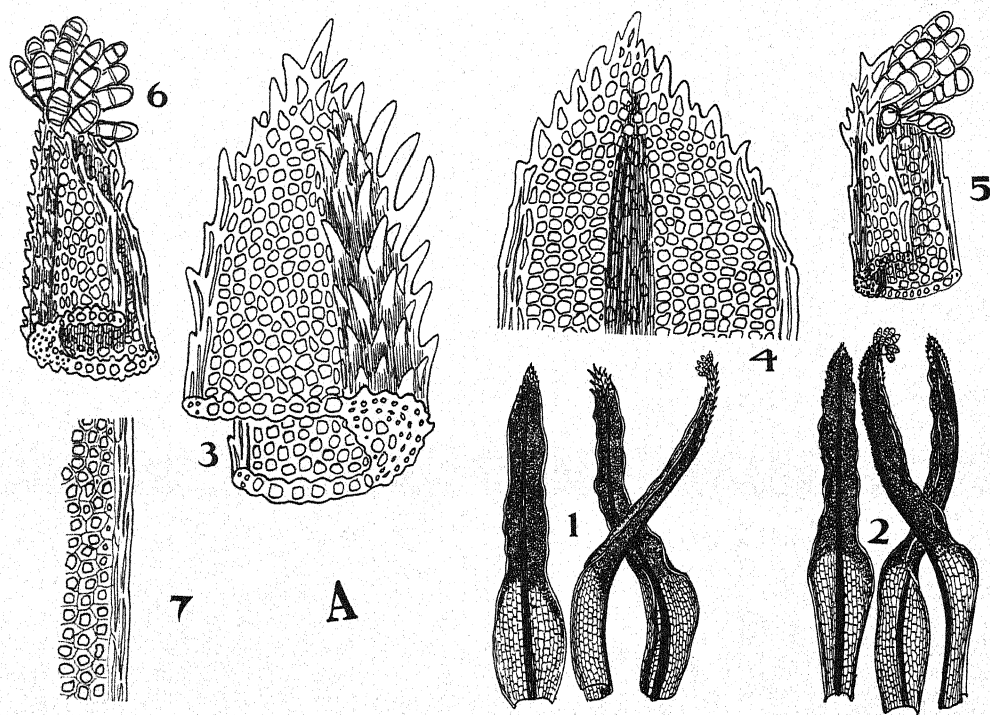


PLATE 122. *Fissidens radicans* (by Seville Flowers). 1, plant $\times 8$; 2, leaves $\times 30$; 3, leaf apices $\times 600$; 4, leaf base $\times 600$; 5, cross section of leaf $\times 600$; 6, capsules $\times 20$.

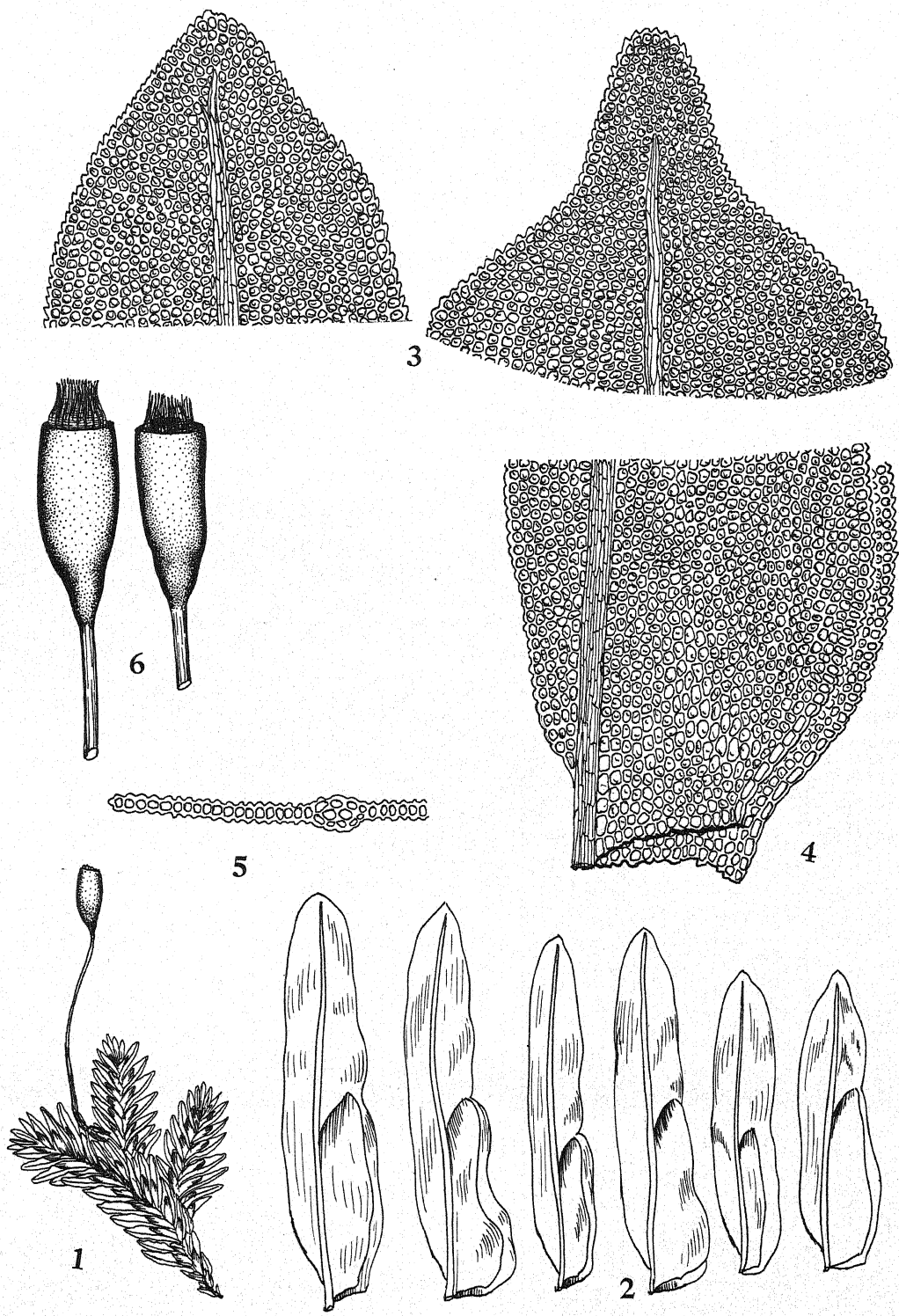
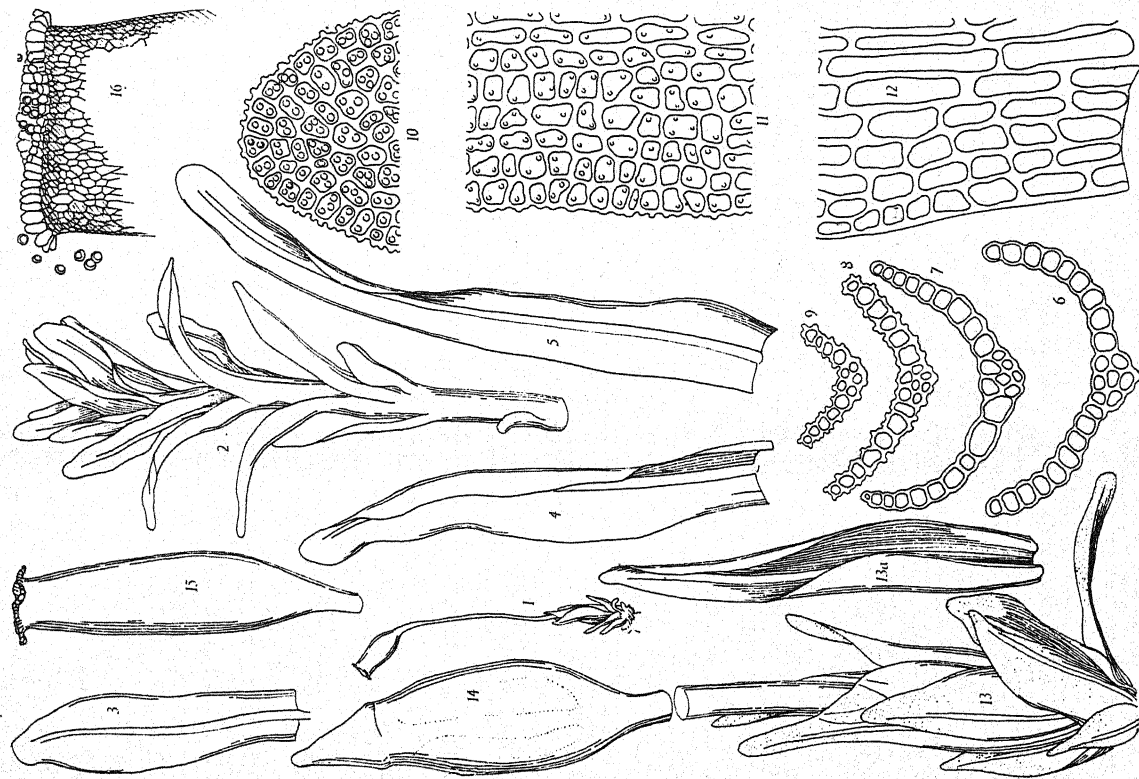


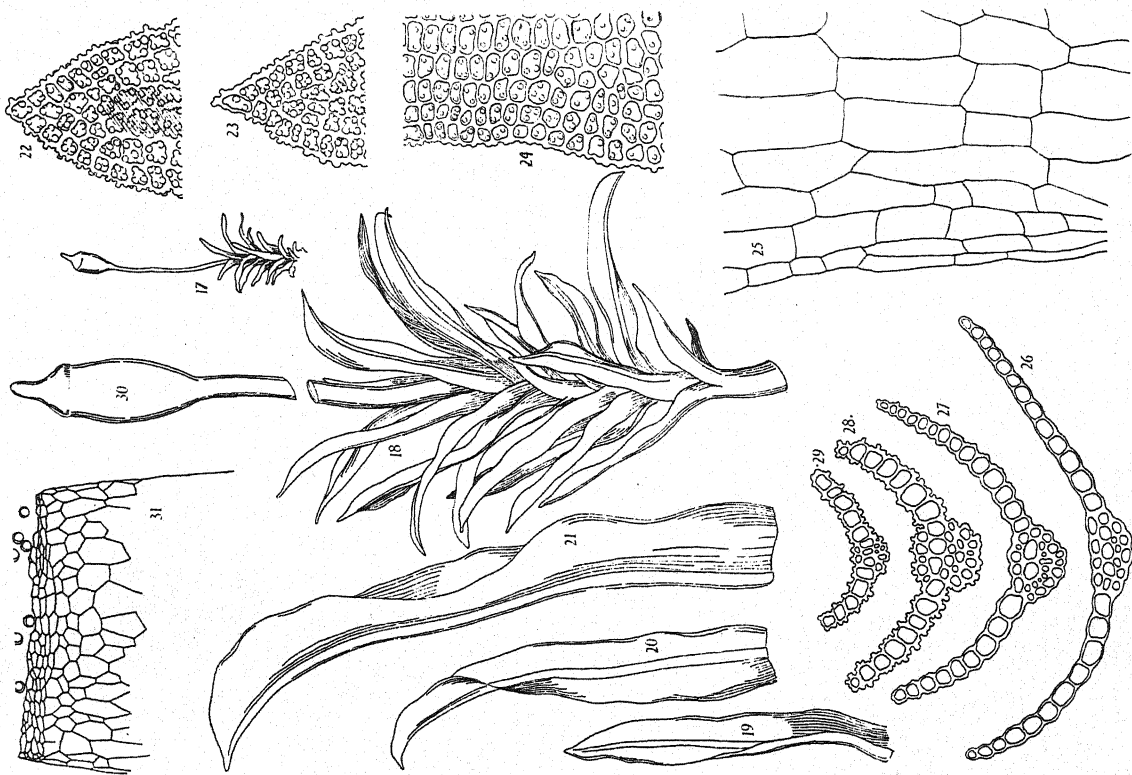
PLATE CXXII

PLATE 123. Figures 1-16, *Gymnostomum tenue* (From Bryol. 42: p. 18). 1, whole fertile plant, showing highly differentiated perichaetial leaves $\times 3$; 2, sterile plant $\times 25$; 3-5, individual leaves progressively longer from base to apex of stem $\times 45$; 6-9, cross sections of leaves from base to apex $\times 380$; 10, leaf apex $\times 380$; 11, cells of leaf margin about midway $\times 380$; 12, basal leaf cells $\times 380$; 13, perichaetium $\times 45$; 13a, single perichaetial leaf $\times 45$; 14, operculate capsule $\times 45$; 15, deoperculate capsule $\times 45$; 16, mouth of urn showing annulus and spores $\times 110$.

Figures 17-31, *Gymnostomum calcareum* (from Bryol. 42: p. 20). 17, whole fertile plant $\times 3$; 18, whole fertile plant $\times 25$, showing undifferentiated perichaetial leaves; 19-21, leaves from base to apex of stem $\times 45$; 22, 23, apex of two leaves $\times 380$; 24, cells of leaf margin about midway $\times 380$; 25, basal leaf cells $\times 380$; 26-29, cross sections of leaf from base to apex $\times 380$; 30, operculate capsule $\times 45$; 31, mouth of urn showing marginal cells and spores $\times 110$.



GYROWEISIA TENUIS (HEDW.) SCHIMP.



GYMNOSTOMUM CALCAREUM NEES ET HORNSCH

PLATE 124. A. *Scleropodium apocladum*. 1, plant $\times 1$; 2, plant $\times 5$; 3, stem leaves $\times 30$; 4, branch leaves $\times 30$; 5, alar cells of stem leaf $\times 600$; 6, alar cells of branch leaf $\times 600$; 7, apical cells of stem leaf $\times 600$; 8, apical cells of branch leaf $\times 600$; 9, median leaf cells $\times 600$; 10, capsules $\times 20$.

B. *Calliergon Wickesii*. 1, portion of plant $\times 8$; 2, stem leaves $\times 30$; 3, branch leaves $\times 30$; 4, lower leaves $\times 30$; 5, alar leaf cells $\times 600$; 6, apical cells $\times 600$; 7, median cells $\times 600$. (All drawings by Dr. Seville Flowers.)

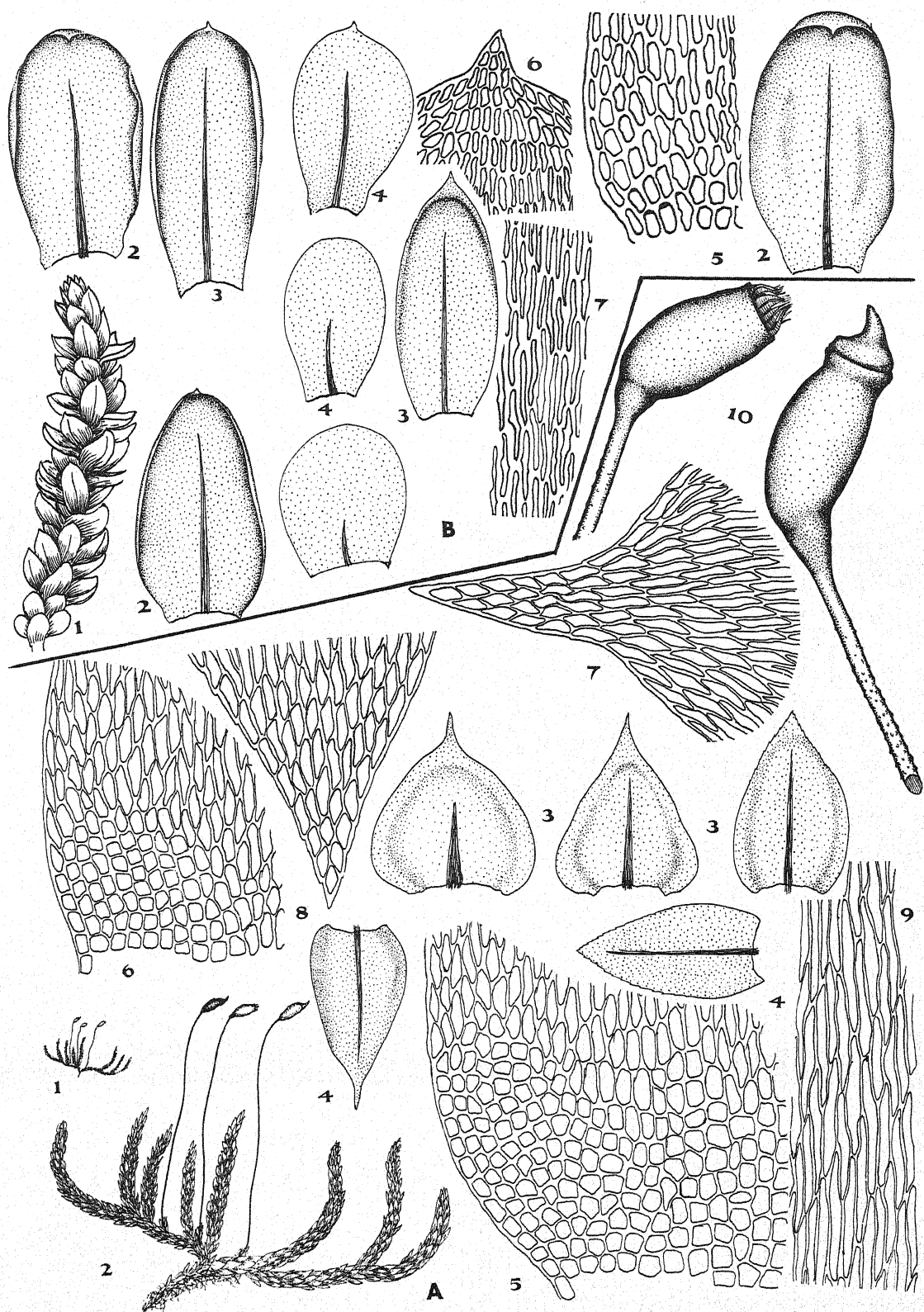


PLATE CXXIV

PLATE 125. A. *Brachythecium edentatum* (drawings from the type by R. S. Williams). 1, plant $\times 1$; 2, capsule and operculum $\times 10$; 3, stem leaf $\times 10$; 4, inner perichaetial leaf $\times 10$; 5, outer perichaetial leaf $\times 10$; 6, basal cells of branch leaf $\times 200$; 9, basal cells of stem leaf $\times 200$; 7, median leaf cells $\times 200$; 8, antheridial bud $\times 10$; 10, part of peristome $\times 200$.

B. *Eurhynchium Brittoniae*. 1, stem leaves $\times 20$; 2, branch leaves $\times 20$; 3, apex of stem leaf $\times 400$; 4, apex of branch leaf $\times 400$; 5, basal and alar cells of stem leaf $\times 400$; 6, median cells of branch leaf $\times 400$; 7, median cells of stem leaf $\times 400$.

C. *Scleropodium californicum*. 1, stem leaves $\times 20$; 2, branch leaves $\times 20$; 3, apex of stem leaf $\times 400$; 4, apex of branch leaf $\times 400$; 5, basal and angular cells $\times 400$; 6, median leaf cells $\times 400$. (Drawings for B & C by Dr. Seville Flowers.)

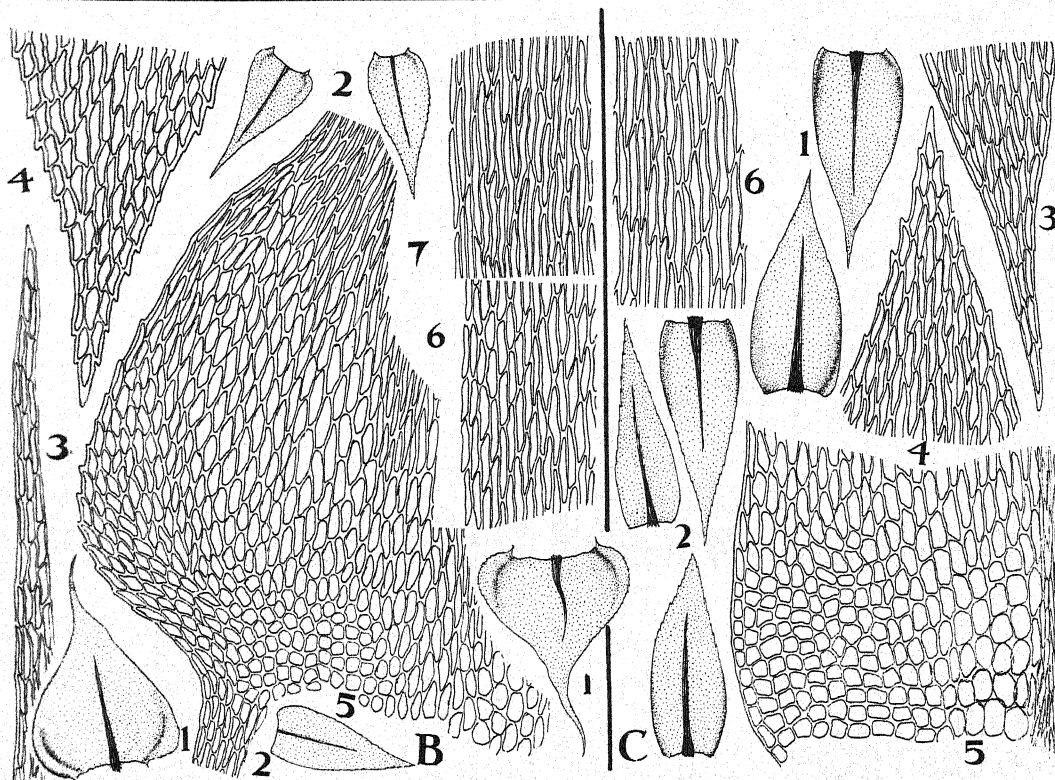
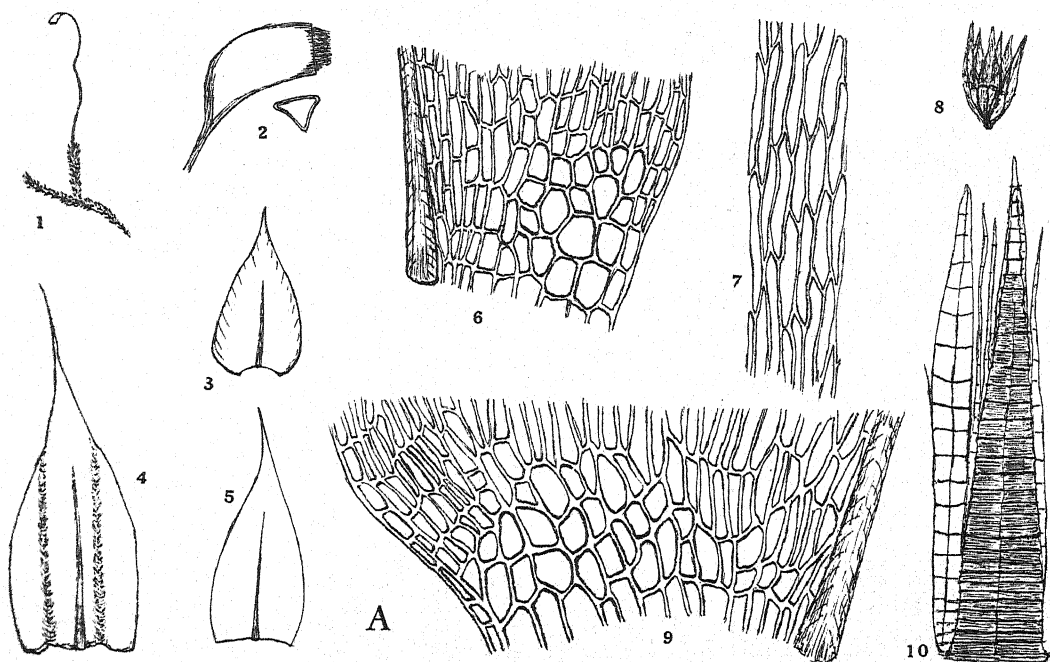


PLATE CXXV

PLATE 126. *A. Brachythecium roteanum*. 1, plant $\times 3$; 2, stem leaves $\times 20$; 3, branch leaves $\times 20$; 4, leaf apices $\times 400$; 5, basal and alar leaf cells $\times 400$; 6, median cells $\times 400$; 7, capsule $\times 13$.

B. Chamberlainia biventrosa. 1, stem leaves $\times 20$; 2, branch leaves $\times 20$; 3, leaf apices $\times 400$; 4, alar cells of branch leaf $\times 400$; 5, alar cells of stem leaf $\times 400$; 6, median leaf cells $\times 400$.

C. Brachythecium Bolanderi. 1, plant $\times \frac{2}{3}$; 2, plant $\times 3$; 3, stem leaves $\times 20$; 4, branch leaves $\times 20$; 5, leaf apices $\times 400$; 6, alar cells of stem leaf $\times 400$; 7, alar cells of branch leaf $\times 400$; 8, median cells $\times 400$; 9, deoperculate capsules $\times 13$; 10, base of seta and perichaetium $\times 13$; 11, capsule $\times 13$. (Drawings by Dr. Seville Flowers.)

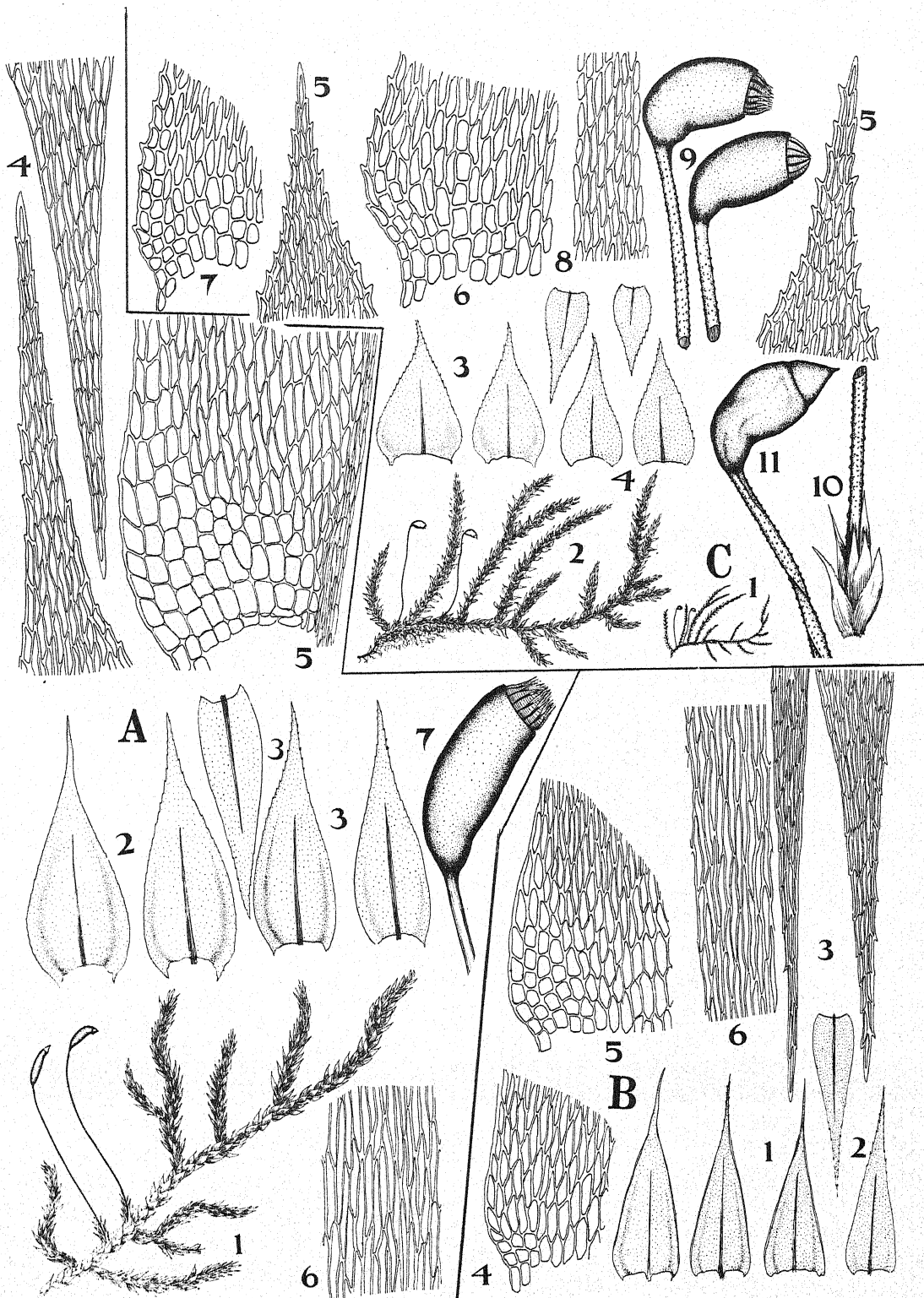


PLATE CXXVI

PLATE 127. A. *Brachythecium Wootonii*. 1, plant $\times \frac{2}{3}$; 2, plant $\times 3$; 3, stem leaves $\times 20$; 4, branch leaves $\times 20$; 5, leaf apices $\times 400$; 6, basal and alar cells $\times 400$; 7, median cells $\times 400$.

B. *Brachythecium cavernosum*. 1, plant $\times \frac{2}{3}$; 2, plant $\times 3$; 3, stem leaves $\times 20$; 4, branch leaves $\times 20$; 5, leaf apices $\times 400$; 6, alar leaf cells $\times 400$; 7, median cells $\times 400$. (All drawings by Dr. Seville Flowers.)

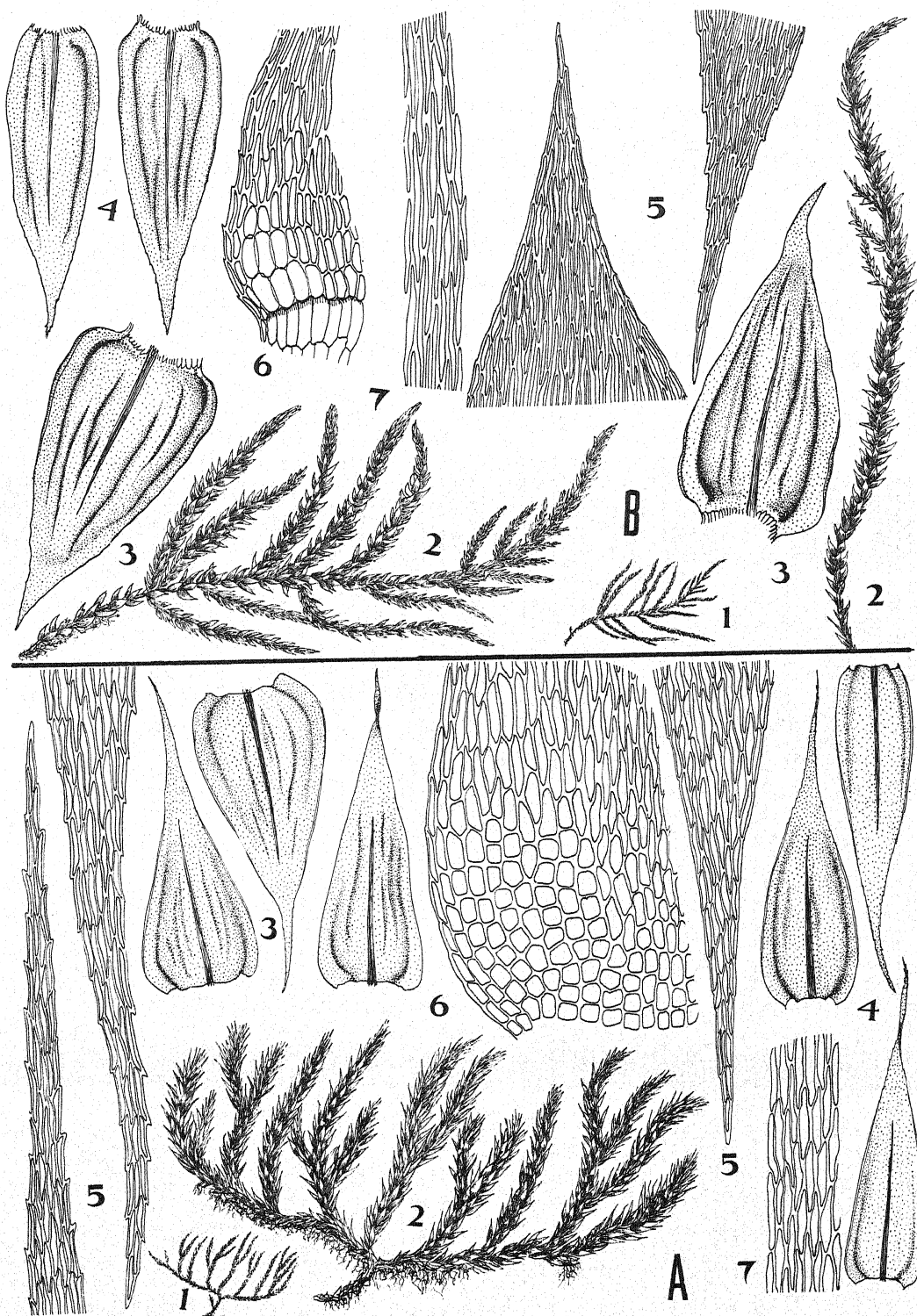


PLATE CXXVII

PLATE 128. A. *Brachythecium Leibergii*. 1, plant $\times \frac{2}{3}$; 2, plant $\times 3$; 3, stem leaf from type $\times 20$; 4, branch leaves from type $\times 20$; 5, branch leaves from Allen, Mosses Cascade Mts. 105a $\times 20$; 6, stem leaves of the same $\times 20$; 7, leaf apices, type $\times 400$; 8, basal and alar leaf cells $\times 400$; 9, median cells $\times 400$; 10, capsules $\times 13$.

B. *Bryhnia Hultenii* (from type material). 1, stem leaves $\times 20$; 2, branch leaves $\times 20$; 3, leaf apex $\times 200$; 4, basal marginal leaf cells above alar cells $\times 200$; 5, median leaf cells $\times 200$. (All drawings by Dr. Seville Flowers.)

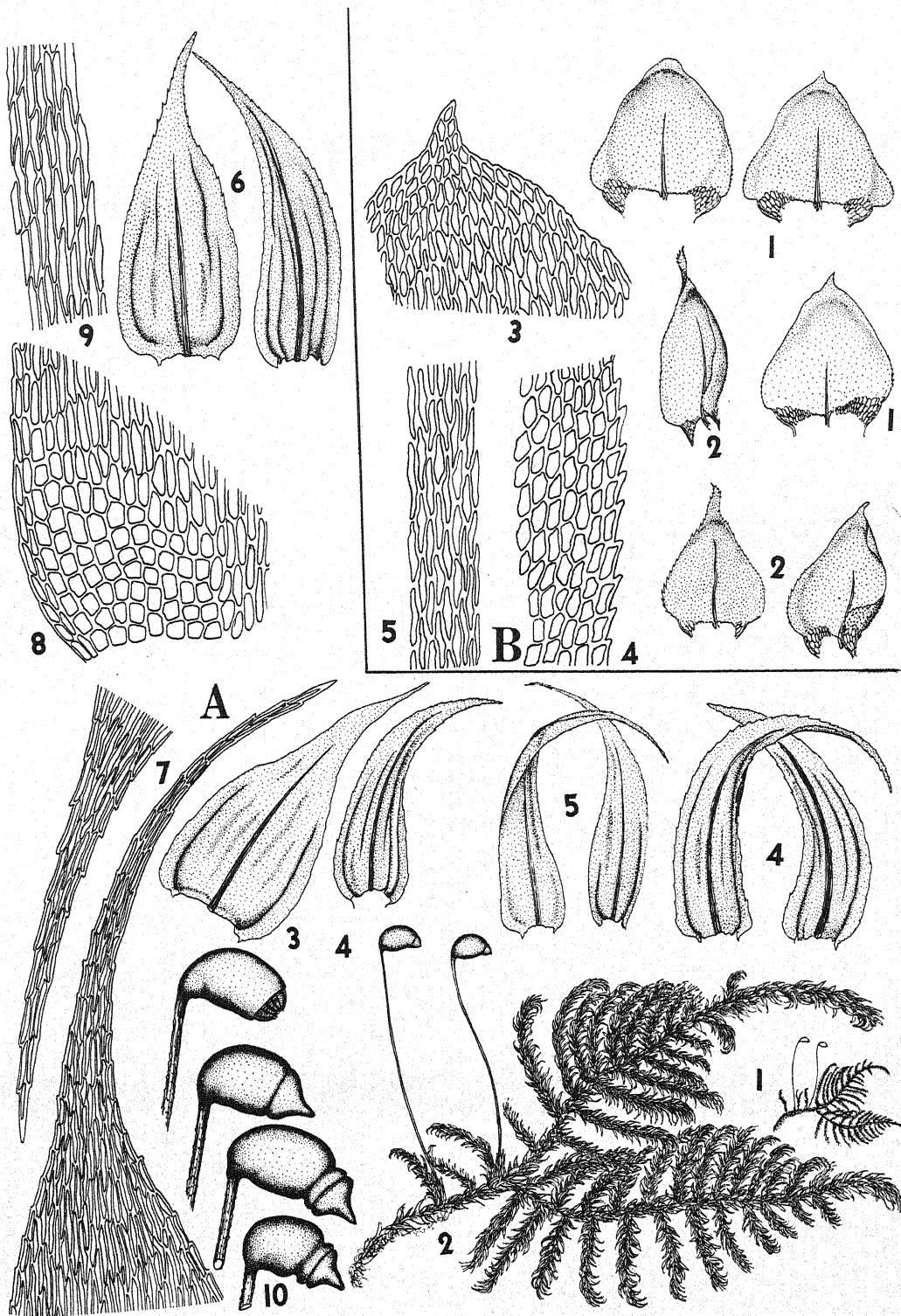


PLATE CXXVIII

PLATE 129. Lower portion. *Brachythecium Holzingeri* (drawings by Dr. Seville Flowers). 1, plant $\times 1.3$; 2, antheridial bud $\times 13$; 3, stem leaves $\times 20$; 4, branch leaves $\times 20$; 5, upper branch leaves $\times 20$; 6, base of stem leaf $\times 200$; 7, apices of stem leaves $\times 200$; 8, apex of branch leaf $\times 200$; 9, perichaetial leaves and base of seta $\times 20$; 10, capsule $\times 13$.

B. *Hygrohypnum Nicholaii* (from Bryol. 38: pl. 2). a, plant $\times 2$; b, leaves $\times 30$; c, leaf apex $\times 150$; d, upper leaf cells $\times 150$; e, median cells $\times 150$; f, lower margin $\times 150$.

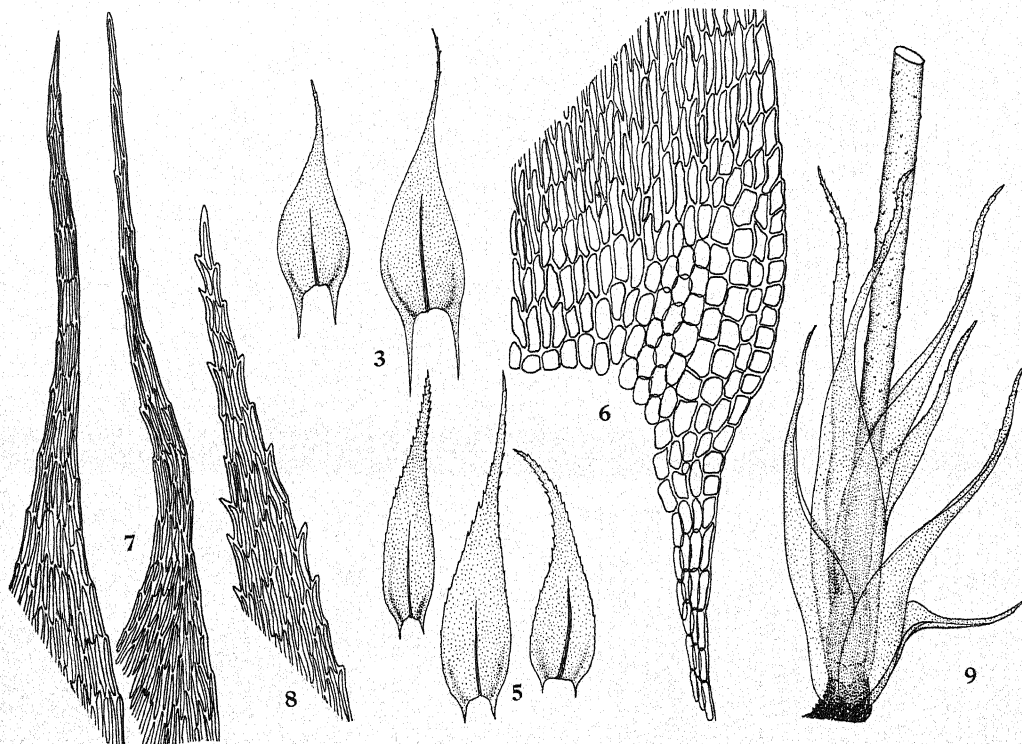
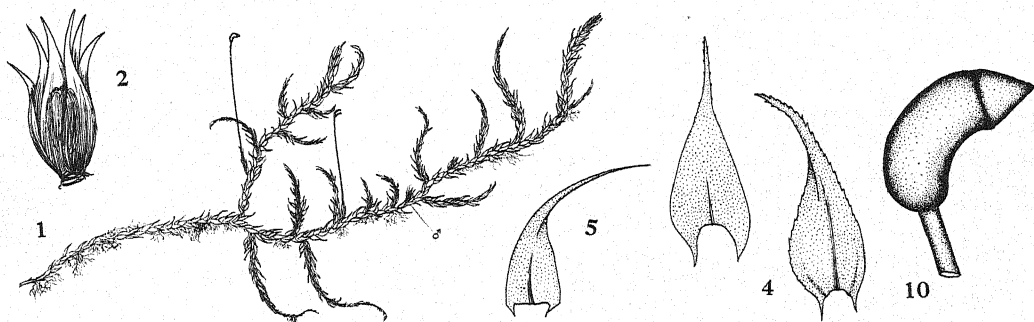
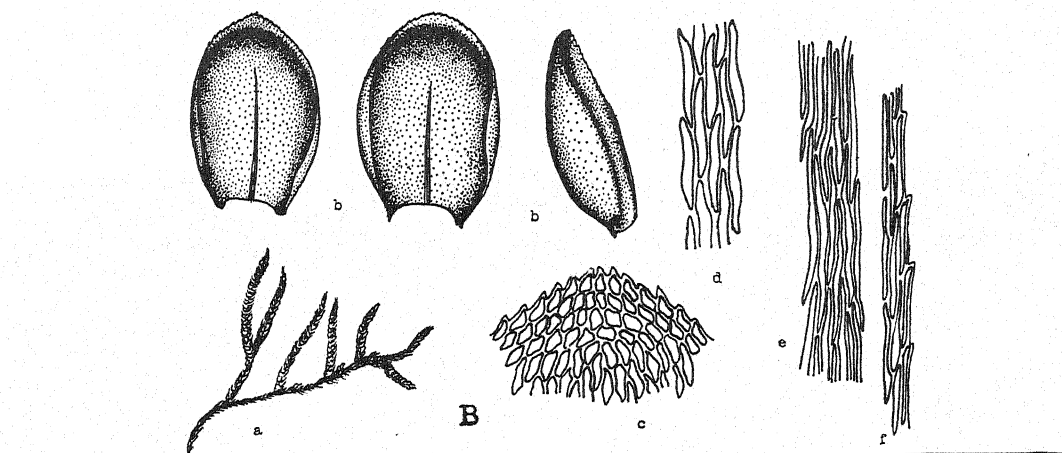


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